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# SCHOOL SCIENCE AND MATHEMATICS

JANUARY 1953

# School Science and Mathematics

*A Journal for All Science and Mathematics Teachers*

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# SCHOOL SCIENCE AND MATHEMATICS

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## SCIENCE AND SCHOOL CAMPING*

GLADYS M. FRIESNER
*Joyce Kilmer School, Indianapolis, Ind.*

On a Monday morning, September 24, 1951, an excited, enthusiastic group of sixth grade youngsters, with their blanket rolls and duffel bags, awaited anxiously the arrival of an Indianapolis Public School bus which was to convey them on their first school camping experience at Hassmer Hill Camp in Versailles State Park, where they could study the science of outdoor life at first hand for one week. Two weeks previously, five other schools had participated in a similar experience. From Joyce Kilmer School No. 69, we were sending fifty-six children and four teachers. They would meet children from two other Indianapolis schools at the park. Interested mothers were there to see them off on their new adventure. At last, the much anticipated bus rolled up, followed by a school truck to carry much of the luggage. A teacher's car was loaded, too, as the fifty-six children each carried a change of clothing, sheets, pillow slips, and at least three blankets. The four teachers, Mrs. Edna Smith, Miss Elizabeth Evans, Mrs. Betty B. Schobert, and Mr. Robert McKay accompanied the group as camp counsellors. They were chosen because of their love for the great outdoors, camping experience, and knowledge of natural science.

As these youngsters travelled along U. S. Highway 421 southeast for about seventy-five miles, they were alert to the historic spots, landmarks, points of interest, types of good and poor soil conservation, and kinds of farm animals grazing on the pasture lands along the way.

Upon arriving at camp about noon, they were ready for lunch,

* NOTE: This article was written upon the request of the editor of General Biology. It is his hope that schools everywhere will investigate the possibilities for such science experiences for the grades, in Nature's own laboratory.—ED.

which had been prepared by cooks hired for this purpose. After lunch, they were shown around the camping grounds and were assigned cabins, each of which had eight single bunks and individual closets. They were to keep their quarters clean and neat, ready for inspection at any time.

Hassmer Hill has a beautiful mess hall with two fireplaces, which afforded much pleasure to these children. Near the mess hall were quarters for a clinic where a school nurse was on duty twenty-four hours a day. Close by were cabins devoted to craftwork. The sleeping areas consisted of two groups of cabins, one for girls and one for boys. The counsellors' cabins were adjacent, each accommodating two teachers. A teacher, if she wished, could camp with her assigned group of youngsters. Each teacher had approximately fifteen children under her supervision. Everyone wore bluejeans, comfortable shoes, and warm coats or sweaters.

While at camp, these children learned to recognize birds, plants, trees, insects, and good and poor soil conditions. They collected clay and twigs for craft work. They hiked to the fire tower, to caves and to other interesting places in the park. They learned what a fire tower was and why they were built and located in these places. The state naturalist, the district extension forester, and the park superintendent helped on the tours and nature hikes. The children loved the park naturalist, who taught them to cast fear aside and become unafraid of the blacksnake. He told them of its usefulness, showed them it was harmless, and they were soon handling the snake.

Each small group planned its own daily field trip. They were posted and cleared so as not to infringe upon earlier plans of other groups. Specimens of leaves, weeds, fossils, and stones were collected, to be used for further study and research upon their return to the classroom. Each group looked forward to the time when they could try their hand at fishing. These youngsters were always ready for meals, which were served at 7:30 A.M., 12:00 M., and 5:30 P.M. Children helped in serving the meals and washing the dishes. Often the camp supervisor would carry picnic lunches to hiking groups. After the evening meal, games were played outside the mess hall area. Later, community sings and movies of conservation were shown, or lectures were given by naturalists.

Difficulties were encountered for both children and counsellors. The teacher had no relief time, she was always on duty. Rainy weather found the cabins drafty and not entirely water tight. Flashlights were soon burned out by too frequent lighting, as the cabins were not equipped with electricity. The cabins also lacked any heating device. No guards were available, so the paths were frequently dotted late at night by the solemn figure of a teacher with a flashlight who felt it was

her duty to patrol the cabin areas, checking each one to see that her charges were covered snug and warm and were safe. It was a great responsibility for these teachers, but it was a learning experience which they are willing to repeat if the opportunity comes again.

It is interesting to note that there were no cases of homesickness, although this was the first time for many of the children to be away from home and both parents over night. There was no friction among the boys and girls, and without exception, the authority of the teacher was unquestioned. Miss Evans, who was a new teacher at our school, relates that she became so thoroughly acquainted with her charges that, during the entire year she served as their home room teacher, it was never necessary for her to raise her voice in reprimand.

After returning from the week at camp, many exhilarating discussions of nature experiences were shared with the class members who had been unable to attend camp. In a testing of plant and insect life, the class made a field trip about the five-acre school campus to identify the many varieties of trees and shrubs. Those pupils who had attended camp far outshone the others in their accuracy of identification.

Since September 1951, twenty-six of our elementary schools have participated in the school camping program. The camp has been in operation three weeks in September and three weeks in May. Ninety children are accommodated at each period of one week's duration. The general conclusions are that upon returning to the classroom, the children were ready for further research about the many things of nature which they had encountered. They had learned appreciation for nature; they had added knowledge of plant and animal life in their natural habitat; they had acquired knowledge of conservation needs seen at first hand; they had grown in the experience of cooperative living and in the practical application of thoughtful courtesy toward others.

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## A NEW ASSISTANT DIRECTOR OF RESEARCH FOR MONSANTO

Dr. Ralph I. Dunlap of Longmeadow, Mass., has been appointed assistant director of research for Monsanto Chemical Company's Plastics Division at Springfield, Mass.

Dunlap joined the division in 1943 as a research chemist and was promoted to group leader in the research department in 1946. He became an operating superintendent in the production department in 1951. And in March, 1952, he returned to the research department as group leader in charge of styrene research.

A native of Jacksonville, Ill., Dunlap was graduated from Swarthmore College in 1940, and received his Ph.D. Degree in physical chemistry from Columbia University in 1943.

## INSTALLATION AND CARE OF TV SET

"Make your television set a member of the family and treat it with care and respect," advises General Electric's chief TV trouble shooter. With millions of families on the verge of being initiated into the wonders of television, W. L. Parkinson, the Company's Product Service Manager at Electronics Park, suggests a number of simple ways they may prolong the life and protect the efficiency of their TV sets.

This TV conservation program, says Parkinson, should begin even before the television set is delivered, by careful selection of the location it will occupy in the home. Like any fine piece of furniture, a television receiver should be protected against exposure to excessive heat. "Therefore," advises G-E's service manager, "don't place it near a heat source or near the thermostat; doing so might mean double trouble." In addition to the possibility of heat damaging the receiver itself, the heat generated by the set may affect the thermostatic control of your heating system and result in a cool house.

Care should be taken, continued Parkinson, to select a location not exposed to excessive dampness and high humidity as might exist near an open or drafty window. At the same time, he warned, placing the receiver too near a wall may cut off air circulation around it and prevent proper ventilation of the receiver which is necessary for trouble-free operation.

Once a proper location is found it's wise to be on hand when the receiver arrives at your home so that it will be set up in your pre-selected position. It is your television dealer's responsibility to see that the set is installed and operating properly at the time it is delivered. It is his further responsibility to see that you are getting the best possible reception for your particular locality and to teach you how to adjust the operating controls for best reception. He can advise if an additional antenna is needed for improved reception, but it is well to satisfy yourself with the picture before he leaves.

Once installed, close attention should be given to proper operation of the receiver. The instruction manual furnished with the set should be read and understood by everyone who would normally operate it. A hands-off policy to casual adjustors is often a good rule to establish in the home. Remember, Parkinson warns, the initial energy required just to heat up your TV set results in far greater wear than continued operation and, for this reason, frequent turning on and off should be avoided.

When reception fails, G-E's service manager advises, check first to see that the receiver is plugged into the electric outlet. It is surprising, he says, how many service calls end with the discovery that the TV set has been disconnected from the wall plug during the day's housecleaning activities.

Secondly, check to see that the antenna lead is connected to the receiver. If you are using an inside antenna make sure it is in the proper position and not draped by curtains, toys or other articles. Remember that all reception difficulties are not due to receiver failure. Television station failure, Parkinson points out, is often at fault and he suggests switching to another channel, if one is available, before calling a serviceman.

When these simple checks fail to correct reception, follow the instructions outlined in your Service Contract if you have one. If you have no Service Contract, call your dealer or a qualified serviceman, making sure he is approved by the wholesale distributor or manufacturer. Your wholesaler, Parkinson believes, will be able to advise you on that score. When you call your approved serviceman be ready to describe in detail reception difficulties. This will help him to be prepared to correct your trouble without undue delay and may prevent returning to his shop for additional parts or equipment.

Above all, Parkinson says emphatically, unless you are a qualified television serviceman, do not remove the back of your television receiver. Attempting amateur repairs, he warns, may prove costly and dangerous. What may seem a simple adjustment to you might result in unnecessary service expense.

# HUMAN CONSERVATION*

JAMES SANDERS
*Chicago Teachers College, Chicago 21, Ill.*

People are our most important product. Their welfare—physical, intellectual, moral—including ethical and spiritual values, is our greatest responsibility. There are more than 7,000 additional Americans daily[1] (from 1947–1950 new births averaged 3,500,000 annually). If we assume that each child costs his parents $300.00 by the close of the first day after birth and an additional $600.00 each year for 21 years (Federal Income Tax deduction) and then add to this the cost of public schooling, exclusive of professional education, the figures become astronomical. By 1975 there should be an estimated 34,000,000 additional citizens. To support them land will have to produce 20% more or we will need more acreage. The present acreage deficit each year is approximately 2½ millions[2] below this increasing need, and the potential productivity of what is left is declining. There is additional food loss of $4,000,000,000 a year from insects. Our 155,000,000 rats eat $500,000,000 a year or the production of 265,000 farmers. Food spoilage from farm to consumer is 30%, and even in grain, spoilage may run from ½ to a billion dollars a year.

Increased populations in civilized nations results in greater numbers of elderly persons with economic, health, and social problems increasing disproportionately in the United States. The life expectancy for a white male is 72.44 years (if he has lived to fifty), and for a white female is 76.16.[3] According to the Annual Report for 1950 of the Chicago Health Department the average life span for males in Chicago is 68 and 70 for females. Of the present population (United States) 8%[4] or about 13 million are over 65; by 1975 this should be 11% or 20,000,000 and by 2000 the number over 65 is expected to reach 13% of the total. Dr. (Sir) Charles Galton Darwin[5] suggests that we are probably living in the golden age of man with shortages of food, water, fuel and essential metals, inevitable. It is believed that man has been in existence about 1,000,000 years. If the next million years sees an increase of only 3–5 times the present total number, living standards as we know them today must be quite different and lower. Future man may be more intelligent, but not necessarily better, the attributes we term noble do not necessarily contribute to survival.

Aging populations will likely have to work longer. Today more than half of men between 65–69 are working[6] and about 3% are seek-

* Read at the Elementary Science section of the Central Association of Science and Mathematics Teachers at Chicago, November 28, 1952.

ing work, between 70 and 74 40% are at work and past 75 the percentage drops below 20. Of women between 65–69 about 87% are neither working nor seeking work.

Surveys of entire populations show that for the older persons short time illnesses cause relatively few lost work days but long term illnesses, disability over 30 days, is more than twice that of the general population. The total period of disability is more than twice the average of the general population. Acute illness tends to level off at age 20 but rises at 60 while chronic illnesses start to increase at age 40. At 65 hospitalization rates for chronic illnesses is 3 times as great as for the general population. Degenerative diseases produce one third of their disabilities as contrasted with 10% for the general population. Heart disease heads this list and by 1975 it is estimated that cardiovascular and kidney diseases will disable 3.8 millions above age 65 as contrasted to 1.5 million estimated cases in 1935.

Control of chronic diseases at earlier ages is expected to decrease this type of illness in the older age groups.[7]

In 1940 32% of voters were 50 or over, by 1980 about 42% of voters will be above age 50.[8] About 5,000,000 oldsters are now eligible for some kind of social security.

The important killers of American people are grouped in various ways, heart, cancer, cerebral lesions-vascular, nephritis, accidents, pneumonia, tuberculosis, premature birth, diabetes, by different agencies[9] so that it is sometimes difficult to single out the exact position of a specific condition as a cause of death. Heart disease is first with about 500,000 deaths and cancer second with about 200,000 deaths annually. Cancer appears to be killing *more* people than formerly although the actual death rate is declining. It strikes mainly in age groups past 40 and accounted for 13.5% of all deaths in 1946.[10] It seems to be established from animal experimentation that tumor formation may be slowed down by restriction of calories and use of a high vitamin B complex in the dietary intake. This is significant in light of the fact that one-fifth or about 15,000,000 of the United States population over 30 is overweight. 5,000,000 people weigh 20% or more above the ideal.[11] This overweight contributes to other disorders and deaths, especially those of heart and vascular system.

Usually ranking fourth or fifth as a killer of Americans is accidents. In 1951 37,500 died in auto accidents and 1,962,000 were injured, 27,500 were killed in home accidents costing $600,000,000 and an additional 16,000 perished at work, total 71,000 needless deaths. Up to age 35 accidents kill more people than disease.[12] Unfortunately there is a high accident rate among children, conservative estimates suggest that over 90% are preventable. About 5,000 children between

1 and 4 die from accidents every year, between 1930–47 disease death rates declined 70% but the accident rate declined only 20%.

Chronic diseases at least partially disable 12.35 millions of people a year, of which 3,000,000 are under age 20.[13] According to the Better Vision Institute 75,000,000 Americans or about one half of the United States population wear glasses. An additional 30,000,000 need glasses. Broken into age groups 23% of teen age, 42% of 30 year olds, 78% of fifty year olds, and almost every one over 70 need glasses. We spend $5,000,000 a year for eyewash and only $1,000,000 for medical research related to the eye. Unsupervised play accounts for a large part of the 85,000 eye injuries each year among school children.[14] More than half of all blindness can be prevented.[15]

There are 100,000 American children with congenital syphilis, this is entirely preventable.[16]

Even in blood donors between ages 18–59 anemia or blood deficiencies were observed in 1% of all males and 12.6% of all females.[17]

Some general social situations not necessarily medical, but in some instances related, should be mentioned.[18] Alcoholism is said to be the 4th major health problem in the United States. In 1948 there were almost 4,000,000 alcoholics in the United States, an increase of 1,000,000 over 1940. In Nevada the case rate is over 8 out of each hundred adults.[19] There are 100,000 excessive drinkers in Chicago alone.[20] The total amount spent for alcohol, tobacco and cosmetics is almost double the $10,000,000,000 for American education. (Of the proposed Federal Budget for 1952 over $6,000,000,000 was for education and development programs in conservation and atomic energy.)

We spend an estimated $20,000,000,000 on organized gambling or twice the present cost of education, yet during World War II there were 30.2 rejects for educational deficiency (below 4th grade) totalling about 675,000 and of about 31,000,000 school age children 17.8% are not in school. The social costs and consequences of crime are imponderable. Total arrests for 1949 numbered 792,029. Crime rate for 100,000 population is 1,758.99[21] while 5,000 major crimes are committed daily. Monetary costs of crime are difficult to evaluate accurately but are usually very considerable. Convicted criminals are not always below normal in intelligence but may be.

One million American parents have sub-normal children.[22] The total number of mental deficients is 1,500,000 or 1% of United States population, an additional 40,000 a year are being born. There are 9,000,000 persons in the United States with mental illness[23] and they cost state governments a total of $561,000,000. Their own earning loss is estimated at $1,750,000,000 annually.

Another grave problem in all civilized nations is the social loss from non-marriage. In the United States there are over 1,000,000 unmarried men between ages 35 and 45, the numbers of unmarried highly educated professional women are even greater. In addition to this loss it is estimated that World Wars I and II produced 20,000,000 orphans thus causing other social disadjustments.[24]

What shall we do? What can we do? With respect to food and land use we must achieve quickly and effectively a basic knowledge and appreciation of active, dynamic, fruitful conservation. Losses from rats, insects and other similar hazards can largely be prevented by applying more generally what is already known about poisons, insecticides and vermin proofing, also new anti-vermin chemicals are developed faster than we can fully utilize them. Our own grasslands and pastures can be made to produce more milk and meat. The national average of egg production for each hen can be doubled, and yeast and legumes can be used as sources of protein. Proper use of watersheds will clarify streams and lakes to help improve and increase their fish populations; one possibility is the Illinois river, polluted by Chicago sewage effluent as far as Starved Rock, but still the second most productive commercial fisheries stream in the world. A few land frontiers in the United States can be developed by irrigation. Great tracts are still unused in the more extreme temperate climate belts (closer to polar areas) as well as in the tropical Congo and Amazon wildernesses.

Medical research is the broad highway to better health and physical well being for all ages. It is easier for people in good health to be happy and productive and cultural development tends to parallel increasing leisure. Progress in medical research depends basically on animal experimentation, of which only about 5% is surgical.[25] One of the most useful experimental animals is the dog.[26] There are an estimated 17,000,000 dog owners in the United States with 20,000,000 dogs using 1,000,000,000 pounds of prepared food costing about $120,000,000[27] (some figures estimate almost double this, $225,000,000 in addition to $200,000,000 worth of leftovers). In some way or another 1,000,000 dogs each year become estrayed and are put to death by various organizations, political and private, as a so-called humane practice. One-fourth of these strays would be sufficient to supply every one of the 77 American medical schools with all the experimental animals needed. Only 25 of these schools receive any dogs and many of them fewer than half as many as they need. Dogs cannot be reared for experimental purposes because of the relatively great expense, the cost being about $125.00 for each dog a year old.[28] The various Chicago medical institutions received 4,000 dogs from

the city pound in 1951.[29] However this met only a small fraction of their needs, in spite of the estimated 250,000 stray dogs that roam our streets. The solution of health problems rests largely on medical research, which in turn depends upon the experimental approach, where animals are used for test or practice instead of human beings. There is not a single modern treatment, drug, device or surgical skill including the use of radioactive elements, and isotopes created in nuclear reactors used in medicine which has not been pretested on animals.

Accidents can be avoided by education, surveys of danger spots at home, work, and in the community, and by proper school ground supervision. Accidents have one thing in common with alcoholism in that they seem to be partly psychological in origin. Alcoholism is primarily a problem of social understanding and may involve complex psychiatric problems. War is both social and psychological but its beginnings stem from human needs which are essentially biological, man's ability to reproduce tends to outstrip his abi'ity to feed, clothe and house himself. The stresses set up among people who do not have enough of anything to meet their barest needs engenders hopelessness or dissatisfaction. These circumstances and problems are international in scope. Their solution is a world problem.

Actual ways and means of introducing medical progress to children have been outlined and presented in other publications.[30,31] The same is true for conservation.[32] The most available vehicles in the elementary classrooms for these subjects are health education and science, social science is a close second. Health education can be notably enriched by materials dealing with information about experiments being done or which have been done to protect the health of children. Conservation is an integral part of the science program. Community and social viewpoints and consequences can be emphasized in the social sciences. In this present paper some of the links between conservation and human welfare have been established. There are many other obvious areas. As they are encountered they may be fitted into the curriculum. In fact, once interested, the children become enthusiastic contributors from their own experiences.

Whatever the other causes of human misery so long as there is one child underfed, underclothed, underhoused, in poor health, and or misunderstood by the social group of which he should be an integral part, society has not made a full nor adequate use of its capacity to help him care for himself; or in his inability to do this, to look out for him. The blessings of modern life made possible through the discoveries and applications of science must be available to all people of the world, and with mutual appreciation, effort and understanding

plus a little moral courage, war will cease to promise any improvement. We can no longer endure the total cost, economic, cultural, spiritual, of eternal, armed conflict among men.

In the entire pattern of education the most effective presentation to the largest number of minds is at the elementary level. The immensity of the responsibility of the elementary teacher to the future world cannot be summarized or limited or hinted at in a simple statement. The future of the free world of humanity is yours alone. You can hide your head from the brilliant radiance of atomic storms, or you can point to the hitherto undiscovered corners of life which are illuminated and revealed. You can cower in fear or you can walk toward the fiery mushrooming cloud in the confidence of your knowledge. Where you go you take the future generations of mankind in the same manner, with the same attitude, hopeless, or expectant. *Make your choice*, there isn't much time.

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## A PICTURE BOOKLET ON ELEMENTARY EDUCATION

"What do you want the schools to teach your child?" When parents are asked this question, they nearly always want to double the duty of the schools in teaching the traditional 3 R's, Reading, 'Riting, and 'Rithmetic. Many surveys of public opinion agree on this trend. Parents now want the schools to teach the children how to get along with people, the duties of citizenship, and how to make a living. Parents want the help of the schools in teaching what might be called a second set of 3 R's, including Responsibilities, Rights, and Relationships with other people.

This is the theme of *The 6 R's*, new picture booklet from the Office of Education, Federal Security Agency. The new duties of the school add to the difficulties of the schools in a year when approximately 1,700,000 more children are enrolled than ever before in the United States. The public schools need 315,000 new classrooms, 150,000 new trained teachers. *The 6 R's*, and a companion booklet released earlier, *They Can't Wait* (10 cents), will be useful during American Education Week, November 9–15, and at other times when the public is considering needs of the schools.

*The 6 R's*. Office of Education picture booklet. 22 pages. 1952. For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. 10 cents. (Discounts of 25 per cent are given on orders of 100 or more copies to be sent to the same address.)

# REFLECTIONS ON THE ACHIEVEMENTS OF MAN

JULIUS SUMNER MILLER*
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The question I put is this: what would you rank as the *greatest* accomplishments of the human mind? This question has at once some philosophic implications, which makes it difficult if not impossible to arrive at "tangible" decisions. As Ramanujan put it: "All religions must be true." But after some penetrating inquiry I rank among all the staggering achievements of the human mind these three as foremost: *communication*, oral and symbolic; the discovery of the *wheel;* the command of *fire.*

By communication I mean the transmission of ideas by mouth and by written symbols. The advances in *this* achievement, from the monosyllabic utterances of primitive man and his stone drawings, to the incredible devices of the 20th century, are too well known to require commentary. The wilderness of wonders which has come from De Forest's vacuum tube needs no recitation, and the utilization of electromagnetic energy borders on the miraculous. And the end is not in sight. With the mysterious transistor new and endless horizons are open and the next half century is destined to outshadow the 50 years just passed.

On the face of it the discovery of the wheel appears to have only small moment, but this is how the commonplace comes eventually to be regarded (or disregarded!). What is around us in abundance is little esteemed—like the dandelion —although in truth this flower is majestic to behold. (Look at one closely some time and discover for yourself its intrinsic beauty.) But of the wheel again—it *now* appears that its innovation was inevitable. How easy it is to say this. Yet when the first primitive found that he could move his load more easily by rolling it than by sliding it the history of man took on a new complexion. Need we recite what men have done with the wheel?

For the utilization of fire shall we make a case? No attempt to appraise *its* place in man's history can meet with much success, for suppose that we should suddenly be reft of it?

In this brief discussion we are hard put to distinguish discovery from invention. In the last analysis we need make no distinction. What we are looking at are the achievements of man, and all of these seem to reduce essentially to this: Nature abounds with infinite wealth. As time goes men master its manifold mysteries. It seems, therefore, that the *destiny* of man lies with him also.

* Ford Foundation Fellow, Department of Physics, University of California at Los Angeles.

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## AN EDITOR BECOMES DEAN OF EDUCATION

Prof. Kenneth E. Anderson, in charge of our Science Demonstrations department, became dean of the College of Education, University of Kansas on November 1. He is one of the country's most active men, a high school chemistry teacher who became a teacher of teachers, a successful executive, a director of research, and an author of important articles and books. Only a few years ago he was director of the University of Minnesota High School, then served a year as principal of the Teachers College High School at Cedar Falls, Iowa, and became an assistant professor at Kansas University in 1948. Within a few years he advanced to a full professorship and to the important position of Dean of Education.

Dr. Anderson has made a thorough study of the education of Indian children while working as a consultant to the U. S. Indian Service. His new book, *The Educational Achievement of Indian Children*, will be published soon.

Our congratulations to you, Dr. Anderson, and to the lucky state of Kansas.

# CAREERS FOR WOMEN IN PHYSICS

VIRGINIA M. BRIGHAM
*Simmons College, Boston Mass.*

For many years science was considered to be a field for men only. Possibly a woman would be allowed to hold a job as laboratory technician if the duties were strictly routine and required no original thought. But all this is now in the past.

Practically every field of science is now open to women and there is no reason to suppose the situation will not continue to improve. Many high school girls might become interested in scientific careers if they were only introduced to the opportunities offered.

In the field of physics the positions available are many and varied, since physics includes mechanics, heat, acoustics, electricity and magnetism (including electronics), optics, nuclear physics, etc. Typical scientific positions held by recent women college graduates are: assistant to an engineer in the development of new types of radio tubes; one member of a scientific team studying improvements in fuel combustion for airplane engines; assistant in a laboratory where synthetic crystals are grown and used with new X-ray techniques; finding the physical properties of new elements recently discovered; studying the age of the earth by means of radioactive calculations; writing reports on scientific projects from notes made by engineers carrying out the research; abstracting recent literature—English, German, French, Russian—for the use of research workers; research on cancer and other diseases in various hospitals; and many others.

Opportunities are available to college students for part time and summer employment in some United States Government laboratories as well as in industrial laboratories, especially in the larger cities. Not only does this provide a source of income but also it furnishes experience and contacts which are useful when the girl is looking for permanent employment.

How would a girl know whether she has an aptitude for one of these jobs? If she likes mathematics and does well in her mathematics classes, and if she likes to find out why and how things operate, then she will probably make a physicist. Also, she must like to work with her hands as well as her head, and she must not object to getting her hands dirty. The research jobs often do not lend themselves to the conventional 8:30 to 4:30 hours. Some measurements, once started, must be completed at one session. The report writing and abstracting jobs require the girl to work under pressure and to make deadlines periodically.

As preparation for a career in physics, the girl should take the college preparatory course in high school and include as much mathematics as possible. Then she should pick a college with a strong physics department. This may be either a co-educational college or a college for women only. The college catalogue will list the courses offered, and the catalogues are available for the asking. The college course will include more mathematics along with the specialized physics courses.

When she graduates she should have no difficulty in securing an interesting position with a good salary and plenty of opportunity for advancement.

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## ATOMIC INSTRUMENTS USED IN OIL EXPLORATION

"The recent introduction of atomic instruments in oil exploration has opened up a new geological era," declared James Mitchel, geophysicist of the Radiac Co., Inc., "It has cut millions of dollars from the cost of petroleum exploration and has been a boon to our defense effort. The nitroduction of atomic instruments into the oil industry has resulted in a tremendous drop in extravagant—'wildcatting'—the indiscriminate drilling for oil in territory not known to be productive."

The use of radioactivity detection instruments in oil exploration was an unexpected by-product of aerial surveys for uranium made shortly after World War II by several Canadian "flying physicists." However, it is believed that the Russians used this technique in the early thirties. Russian scientists have been using radioactivity detection instruments for cosmic ray studies for many years.

While prospecting for uranium from low-flying aeroplanes, the Canadians used the latest innovation in airborne atomic instrumentation, the "Scintillometer," an ultra-sensitive gamma ray detector, which they had developed. The Scintillometer is several hundred times more sensitive to gamma rays than the Geiger counter. Gamma rays are emitted from uranium in the earth. The Scintillometer measures radioactivity by electronically counting the scintillations of a grid of synthetic crystals struck by atomic radiation. The Canadian geophysicists arrived at a surprising conclusion. Scintillation counting disclosed that almost invariably around the edges of oil fields, there is a "halo" of increased radioactivity. The Scintillometer also revealed that there is less radioactivity directly above the oil fields.

These studies have been of tremendous significance in oil exploration. Indirectly, they have also led to the discovery of valuable minerals, many of which are vital to our defense program.

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## AMERICAN SOCIETY OF PHOTOGRAMMETRY

The 19th Annual Meeting of the American Society of Photogrammetry will be held on January 14, 15, and 16, 1953, at the Shoreham Hotel in Washington, D. C. The program will be highlighted by a panel on "Arctic Mapping" as a joint project of Canadian and American speakers and by a full day devoted to "Photo Interpretation" with its applications to the sciences, industry, and military intelligence. The public is invited to view the exhibits and display of maps and camera and photogrammetric equipment. For the technical sessions, the registration fee is $2.00 with free admission to organized student groups.

# PRODUCTS OF NUMBERS ENDING IN 5

E. A. TABLER
*The University of Akron, Akron 4, Ohio*

Special rules for finding products, mentally, of two numbers ending in (5) for special cases such as (a) and (b) below, are quite common, but I do not recall having seen a generalization or extension of such processes to cover all possible cases. May I submit such a general rule, with proof, which you may consider of interest to readers of SCHOOL SCIENCE AND MATHEMATICS.

## SPECIAL CASE (a)

Numbers ending in 5 and preceded by the *same* digits. Example: $65 \times 65$.

*Procedure:*

Add (1) to the part of either number which precedes the 5 as $6+1=7$.

Multiply this sum (7) by the part of the other number preceding the 5 as $7 \times 6 = 42$.

Product always ends in 25.

The product is 4225.

## SPECIAL CASE (b)

Numbers ending in 5 and preceded by digits which *differ by (1)*. Example: $105 \times 95$.

*Procedure:*

Add (1) to the part of the larger number which precedes the 5 as $10+1=11$.

Multiply their sum (11) by the part of the other number preceding the 5 as $11 \times 9 = 99$.

Product ends in 75.

The product is 9975.

## GENERAL CASE (c-1)

Numbers ending in 5 (all cases including (a) and (b) above). Example: $85 \times 35$.

*Procedure:*

Add the parts preceding the 5 of each number as $8+3=11$.

Divide the sum (11) by $2=5$ plus (exclude fractions).

Multiply the parts preceding the 5 of each number as $8 \times 3 = 24$.

Add product 24 and quotient 5 as $24+5=29$.

If result of first addition is even, number ends in 25; if odd, number ends in 75.

The product is 2975.

### General Case (c-2)

Numbers ending in 5 (all cases). Example: $115 \times 55$.

*Procedure:*

Add: $11+5=16$ (even—ends with 25).
Divide: $16 \div 2 = 8$.
Multiply: $11 \times 5 = 55$.
Add: $55+8=63$.
The product is 6325.

*Proof:*

$$\begin{aligned} \text{One number} &= 10N_1+5=5(2N_1+1) \\ \text{Other number} &= 10N_2+5=5(2N_2+1) \\ \text{Product} &= 25(4N_1N_2+2(N_1+N_2)+1) \\ &= 100N_1N_2+50(N_1+N_2)+25 \\ &= 100N_1N_2+\frac{100(N_1+N_2)}{2}+25 \end{aligned}$$

*Check:*

(By case $25 \times 25$)

$$100 \times 2 \times 2+50(2+2)+25=625$$

(By case $35 \times 25$)

$$100 \times 3 \times 2+50(3+2)+25=875$$

### To Find Product of Any 2 Numbers Ending in 5

*Rule:* To the product of the parts of the numbers preceding the 5 add $\frac{1}{2}$ the sum of these parts, excluding any fraction, and annex 25 or 75 according to whether the sum of the parts is even or odd.

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### MASS-MANUFACTURED GLASS PARTS NOW CAN BE WELDED

Electric welding principles have been adapted to glass, permitting highly technical products to be manufactured better on a mass scale, M. R. Shaw, Jr., research engineer for the Corning Glass Co., reported to the Middle Eastern District meeting of the American Institute of Electrical Engineers.

Mr. Shaw said electric glass welding develops higher temperatures within glass bodies than flames do. The high temperatures are reached faster, and without danger of destroying the surface of the material or of distorting the main body of parts. The heat can be controlled accurately, even by unskilled operators.

Welding voltages run as high as 20,000 volts when glass is being joined. Currents vary from the standard 60 cycles to "ultra high frequency" currents.

# GUIDANCE OF PROSPECTIVE HIGH SCHOOL CHEMISTRY TEACHERS

LEONARD A. FORD
*State Teachers College, Mankato, Minnesota*

The student whose major interest is in the field of chemistry finds it much more difficult to obtain a teaching position in secondary schools today than a few years ago. It becomes increasingly important therefore to give proper guidance to prospective teachers whose interest lies in this field.

An analysis has been made by the author of recent available teaching positions and state and college regulations which apply to positions in the secondary schools.

Letters from school superintendents to the local college teachers' placement office have been examined and requests for teachers of chemistry are rare. Where chemistry is mentioned in the letter it is in combination with general science, biology, physics, and mathematics in that order. Some combinations with physical education, music, and unrelated subjects occur. On examination of 105 requests for teachers in science none was for chemistry alone, 26 combinations of science and mathematics, 25 requests for science alone and 18 combinations of science with athletics or physical education.

The same trend in subject-matter combinations was found by F. R. Adams[1] of the State Department of Education of Minnesota. Graduates of Minnesota colleges in the spring of 1949 who were prepared to teach numbered 279. Of these 130 received positions in the state with 38 in the science field without any other subject matter combinations. It is doubtful that any of these teachers were teaching chemistry alone. The data further indicate that 40 teachers, whose major time in teaching was in science, were teaching some mathematics as well; 18 science teachers had combinations with physical education and 13 with social studies. Others had teaching combinations of science with other fields. Data gathered by the University Placement Office showed the same type of subject-matter combinations for teachers of science. The conclusion to be drawn from these facts is that the chemistry teacher must be prepared to teach any of the sciences taught in the high school. Preparation in mathematics is desirable and ability in athletics and music is helpful.

The prospective chemistry teacher in a high school is required to complete a specified number of courses in education and practice teaching. These requirements range from 15 to 30 semester hours and are prescribed by the institution and the state department of

[1] Data supplied by F. R. Adams, Director, Division of Teacher Personnel, State Department of Education, St. Paul., Jan. 1950.

education. Probably the best summary of state teaching requirements is one by Woellner and Wood.[2] Minimum requirements in education courses are rather easy to interpret but specific requirements to teach chemistry are often buried under such terminology as science, general science, physical science or single subject science. The prospective teacher may select one of four options to teach science in the state of Indiana. The preparation in science ranges from 20 to 36 semester hours in science. The academic requirement of a chemistry teacher in Michigan is not specified in terms of science. Twenty-four semester hours of preparation is required in the major subject with 15 semester hours in each of two minors. A teacher of science in Florida high schools must have 36 semester hours of preparation but if he teaches a single subject, 15 semester hours are sufficient. The science teacher in N. Carolina must have completed 30 semester hours in science with 6 semester hours in chemistry if he is to teach that subject.

Requirements for graduation in University colleges of education and teachers colleges vary considerably. A comprehensive major at the University of Wisconsin is made up of 55 semester hours in the science field and at Minnesota the corresponding requirements is 43 semester hours. The comprehensive major in science consists of 36 semester hours at Iowa State Teachers College and 37 semester hours at Mankato. The comprehensive major is more common in teachers colleges and University colleges of education than in liberal arts college.

Careful planning of the entire four-year program in college is essential if the student whose interest lies in chemistry plans to teach in a high school. A carefully planned sequence of courses in chemistry as well as biology and physics must be planned. Mathematics courses should be made to fit into the program. The general education, institutional and state requirements must be satisfied.

[2] Woellner, Robert C., and Wood, M. Aurilla, *Requirements for Certification*, 15th edition, 1950–51, The University of Chicago Press.

## FISH SOUNDS CLUES TO WHERE CATCH IS GOOD

Fishermen may be able to locate and identify schools of commercial fish, long before they would be found otherwise, by using underwater listening devices.

During exploratory cruises in the Gulf of Maine this summer, a group of U. S. Fish and Wildlife Service scientists directed by Virgil E. Harris, electronics expert, made underwater recordings of the sounds of schools of fish. The FWS reports that these recordings will be analyzed and work will be started to develop listening devices particularly sensitive to the sounds of fish of commercial importance, like tuna and mackerel.

The FWS believes that if these listeners are perfected, commercial fishermen will be able to use them to great advantage in tracking down the elusive harvest of the sea.

# WONDERLAND OF GEOLOGY

MARGUERITE E. WOLFINGER
*McCaskill School, Wisconsin State College, Superior, Wis.*

Geology in fifth grade? Enchanting—a veritable fairyland of imagination! What could produce a greater thriller than a sudden explosion on the sun; a whirling off into space; the mists; the incessant rain; waters and the earth; explosions of the volcanoes with fire, rocks, lava, ashes, and smoke filling the air and covering the ground; the onward creeping of the stunning cold of the glaciers; rivers changing course and rushing madly toward the nearest open sea; waterfalls; earthquakes; and all the terrors of the birth of your homelands, picnic spots, and centers of scenic beauty? In these places it prints its own textbook. A bit of rock, a few grains of sand, some twisted and bent trees, a valley between two ridges, an old quarry, some weird rock formation, or an eroded gully, all have tell-tale signs that may afford a child a wealth of enrichment when he has learned to read from the "Outdoor Story-Book."

Scientifically, perhaps, the amount of information gained may be meagre and inconsistently organized, but experientially and appreciatively the results are most satisfying. Children are enthusiastic about trips and picnics. Since the hills and streams are their textbooks, just won't they have fun with them? Children like to collect specimens. They can do so. Maybe they will not be able to identify them a few weeks hence. That's all right, too. They like to take pictures. Let them do that, too. Some may be good, many may not be. They'll put them away and remember that volcanic rock was found at that spot the next time mother or dad go there. Isn't that enough? They'll see some movies. There are many good ones on volcanoes, mountain-building, the work of rivers and glaciers. Some impression will remain with each child. They may not be the one that teacher wanted them to remember, but in the course of his experience, he will have made the acquaintance of such terms as lava, volcanic rocks, molten rocks, faults, veins, glacial deposits, and many others. Maps, too, are exciting when they portray the child's own idea of the places he has seen and when they show the things that he has seen there. Let the children draw them! They will not be perfect but the children think they are. Isn't that enough for fifth grade? These are some of the avenues of expression that are opened for children when their eyes, and minds, and hearts are tuned to see the tremendous forces of creation in the familiar recreation places about them.

The keen, alert and intelligent child cannot long observe these signs of Nature's origin without having awakened within himself a

desire for creative activity of his own. Just what form this activity will assume is hard to foretell. The scientifically-minded child may endeavor to create a volcano which will erupt, or mold a relief map of the terrain visited; whereas, the child who is adept at music may attempt to compose a song; or the child with ability to write may create a story, a poem, or a play; and the artistically inclined child will find an outlet for his talents through sketching the rock stories, illustrating the stories of his classmates, or in designing staging and costumes for their plays.

Just such a program of activity produced the following original play, "Wonderland of Lake Superior," and the original song, "The

The Fairies

Glaciers," as the outcome of a six-weeks geological study of our Lake Superior region by the fifth grade pupils of the Wisconsin State College at Superior Training School.

## WONDERLAND OF LAKE SUPERIOR

Original Play by McCaskill Fifth Grade
Wisconsin State College at Superior

### Characters

Narrator

Rock Fairies (Four)—Brown and yellow tights, with puffy, brown pants and brown jackets and caps.

Lava Fairies (Four)—Red, trailing blanket and red mask, for each one.

Fire Fairies (Two)—Red tights, socks, and flame kilts, wrist bands, ankle bands, and headgear.

SMOKE FAIRIES (Two)—Gray flowing robes or capes and headgear.
EARTHQUAKE GIANT.—Made tall by fastening large cans or blocks to the feet and padding for muscles. Huge, fearsome mask head, shaggy hair, and long black gown.
WATER FAIRIES (Four)—Loose white dresses made of striped crepe paper and tinsel over white cloth foundation. Silver over-seas cap with silver and tinsel raindrops attached.
GLACIER FAIRIES (Two)—Loose ice-blue capes (or white) with tinsel trimming and white, tinsel-trimmed soldier caps.
SANDSTONE FAIRY—Yellow tights and anklets. Brown, pointed jacket with shaded yellow crepe paper streamers to the floor in back. Yellow band with streamers in back for headdress.
MOTHER NATURE—Flowing green voile robe with deep, wide sleeves with tree, vine, or leaf motifs on the sleeves.

### SETTING

Large, erupting volcano on the right, rear stage. Mountains with a small waterfall at center rear. Glacier between mountains at left stage. Front stage in comparative darkness as the curtain opens with the lower mountains lighted with violet and the sunlight touching the mountain tops. Use a fan behind the waterfall of crepe paper and pliofilm strips to create motion. The lower mountains in the center are to be on a screen which can be removed and show a large waterfall behind it.

## ACT I

### SCENE 1

(Chorus sings, "Superior, Thou Mighty Lake"* behind the curtain. Curtain slowly opens on empty stage, as the music gradually changes to rumbling "volcano" music.)

*Narrator:* (Enters slowly and mysteriously from the valley at the rear left. Stands beside the waterfall.) Many thousands of years ago a volcano was formed in Duluth, Minnesota. This started long before man came to America. After many, many thousands of years it was the highest volcano in the world. One day the volcano erupted. It threw lava, rocks, steam, fire, and other materials miles and miles around. There were many eruptions. One day there was a huge eruption. (Red light on the scene.)

(Volcano erupts during speech. At "huge eruption" a firecracker is exploded inside a tin-can and music becomes violent. *Rock Fairies* enter on right and left sides of volcano. *Lava Fairies* enter at front. *Fire Fairies* enter at back. *Smoke Fairies* enter at left and right.)

*1st Rock Fairy:* I am a rock. I was thrown to a place now called St. Croix Falls. (Tumbles and rolls to right front).

*2nd Rock Fairy*: I, too, am a rock. When I was thrown, I rolled and rolled and stopped along the present north shore of Lake Superior. I am called "gabbro." My color is black. Water has caused me to expand in places, so I have many cracks. Now there is plant life growing in these cracks. (Tumbles and rolls to left front.)

*3rd and 4th Rock Fairies:* We are some of the rocks that helped to make the Laurentian Mountain Chain. (Tumble to foot of glacier. Slip under glacier as *Earthquake Giant* comes.)

(During this scene, other rocks—inflated paper bags—are being thrown around the stage near the volcano.)

*Lava Fairies:* We are lava. We spread over the entire Lake Superior region. (Lava Dance.)

*Fire Fairies:* We heated rocks. We melted ore. We heated the land to a tremendous temperature. We caused igneous rock. (Fire and Smoke Dance.)

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* Words and music by Emugene Wyman.

### Scene 2

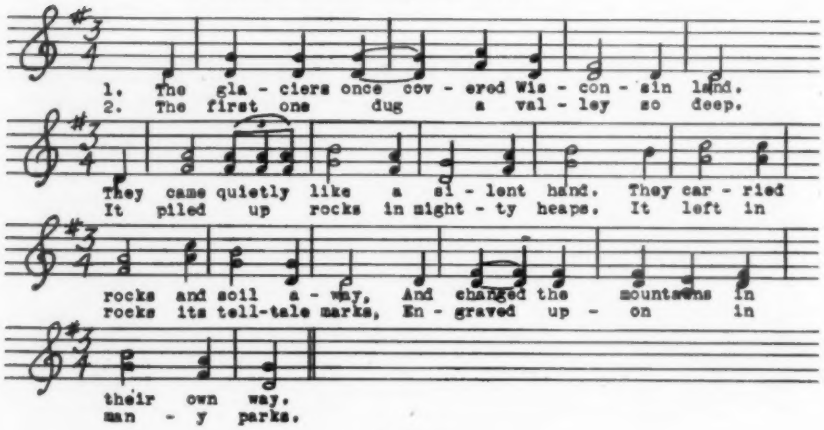
(*Earthquake Giant* enters right. Stomps to center stage. *Rocks* remain very still.)

*Earthquake Giant:* I am the earthquake giant. I make all earthquakes. I cause the earth to rise and sink. This makes what we call faults, sinks, fault scarps, hanging walls, and other defects in the earth.

(Shakes mountain on screen at center of stage, causing it to fall. A larger waterfall appears. *Rocks* tumble wildly in the excitement. *Water Fairies* peek from behind the falls.)

**THE GLACIERS**

(Words and music composed by
Grade 5, McCaskill School, 1951)


1. The gla - ciers once cov - ered Wis - con - sin land.
2. The first one dug a val - ley so deep.
They came quietly like a si - lent hand. They car - ried
It piled up rocks in migh - ty heaps. It left in
rocks and soil a - way, And changed the mountains in
rocks its tell-tale marks, En - graved up - on in
their own way.
man - y parks.

## ACT II

### The Glacier Period

("Ice music." Stage lighted a frosty blue and is empty. *Narrator* enters from valley at rear-center.)

*Narrator:* Many millions of years after the volcanic period, several ice sheets descended upon the Lake Superior region. It changed the surface of the land. It gouged out places, leaving deep valleys. It deposited all kinds of rock that was picked up on its journey from the north.

(Original song, "The Glaciers," sung by the chorus backstage. *Glacier Fairies* enter slowly moving glacier—a sheet. Glacier retreats and uncovers *Water Fairies* and *Rocks* until half-way back.)

*Glacier Fairies:* We are glacier goblins. We are made of ice and snow, earth, rocks and other materials. It took us thousands of years to grow. As we grew, we moved along, taking the earth, rocks and sand with us. We left our traces in many rocks. We deposited many rocks. We left many traces in the surface of the land. (Glacier music continues during speech. Song may be sung again here.) OH-h, but we must go, as the climate is too warm for us here! (Run off to left.)

(*Water Fairies* keep peeking up as the *Glacier Fairies* talk. Jump up and dance when the *Glacier Fairies* run away.)

*Water Fairies:* We are water fairies. We were made by the melting glaciers.

*1st and 2nd Water Fairies:* We formed many lakes and rivers.

*3rd and 4th Water Fairies:* We drained into the Lake Superior Valley (dance to right and left stage) and made the Lake Superior waves.

(*Waves* enter from right with short running steps. Swing fans to ground like one big wave.)

*Waves:* We do much damage. We cause erosion. With our strong attacks on shores, we send sand to other shores.

(*Sandstone Fairy* slips in unseen at center back as *Waves* enter and remains stooping down until after they speak. Jumps up.)

*Sandstone Fairy:* Hello! I'm the little sand particle that was washed and blown across Lake Superior from Park Point. I lived at Park Point a long time. Then, all at once I was blown out into the lake. (Starts dancing among the *Waves.*) I saw so many waves that I just couldn't talk to them all. I had a nice merry-go-round ride all the way over the lake. I was washed around in the great big lake to the south shore of Lake Superior and here I am now. (Arrives at the center-front stage.) I am telling you the story of how I came across Lake Superior from Park Point to the south shore of this very large lake. (Swished off stage by *Waves.*)

(*Rock Fairies* begin to tumble and roll together.)

*1st Rock Fairy*: Do you see the scars all over me? I received these scars many, many thousands of years ago. I took a long journey to this place with the glacier. As I was rolling along, the larger and harder rocks passed me and scratched me. But I should not complain! Many, many rocks were ground up to a very fine powder!

*2nd Rock Fairy:* I was carried along with the glacier, too. I rolled and tumbled. (Roll and tumble.) I bumped other rocks. (Bump others.) I rolled and rolled again, (Roll.) and again. Now you see that I am round and smooth and polished.

*Other Rocks:* We are all glacier deposits. There are so many kinds of rocks here that it is hard to find any of my relatives. Perhaps some of my kind of rock was deposited many miles from here. Erosion is causing many of us to crack, break, and crumble away.

(*Rocks* tumble and roll to the foot of the waterfall. *Water Fairies* dance out from the waterfall around the *Rocks.*)

*1st Water Fairy:* When Lake Superior Valley was filled up, there was not enough room for all of us, so many of us had to leave the lake. We formed a river that you now call the Brule River. It was once a mighty river and flowed southward. Now it is only a small one, because the waters have changed their course and flow into Lake Superior, not out of it. We are now an outlet of Lake Nebagamon.

*Other Water Fairies*: (Dancing and talking all at once like the waterfall.) We are outlets of Lake Amnicon. We rush rapidly over rocks, (Rush back and forth over the *Rocks.*) boulders, cliffs, jagged rocks and other deposits that were caused by glaciers. We have been given the name of Amnicon Falls. We, too, flow into Lake Superior.

(Lights dim. *Water Fairies* and *Rocks* fade away behind the Waterfall. Violet light and sunlight on the mountains. *Mother Nature* is seen coming slowly down the mountain and toward the center-front of the stage. Brought in by the spotlight.)

*Mother Nature*: I work in very strange ways. I have made for you a beautiful place in which to live. This has taken many millions of years. Work has been going on all of the time. I am still working. My helpers, the volcano, (Enter *Rocks, Fire, Lava, Smoke*) the Earthquake, (Enter *Earthquake Giant*) the glaciers, (Enter *Glacier Fairy*) and the waters (Enter *Water Fairies, Waves, Sandstone Fairy*) have made for you a fascinating landscape. Your vacations can be filled with the great joy of fishing, swimming, hunting, boating, or of just admiring the beauty that is yours in this beautiful fairyland. Not only is this a place of beauty; and a place to vacation, but my helpers and I have provided for you many resources for industry, such as mineral ores, wood products, and waters to transport them on. Is it any wonder that we call this the "Wonderland of Lake Superior"?

(Tune: *America, the Beautiful* begun during speech with children softly humming. At end, the children sing the following words to it:

Superior Land, Superior Land,
God shed His Grace on thee,
And crown thy good with *endless peace**—
Upon our Inland Sea.

(Curtain slowly closes.)

* Dove lights on Mother Nature's hand.

## A MICROSCOPE FOR THE JUNIOR SCIENTIST

LOUIS RZEPKA
*4023 Lawndale, Detroit, Mich.*

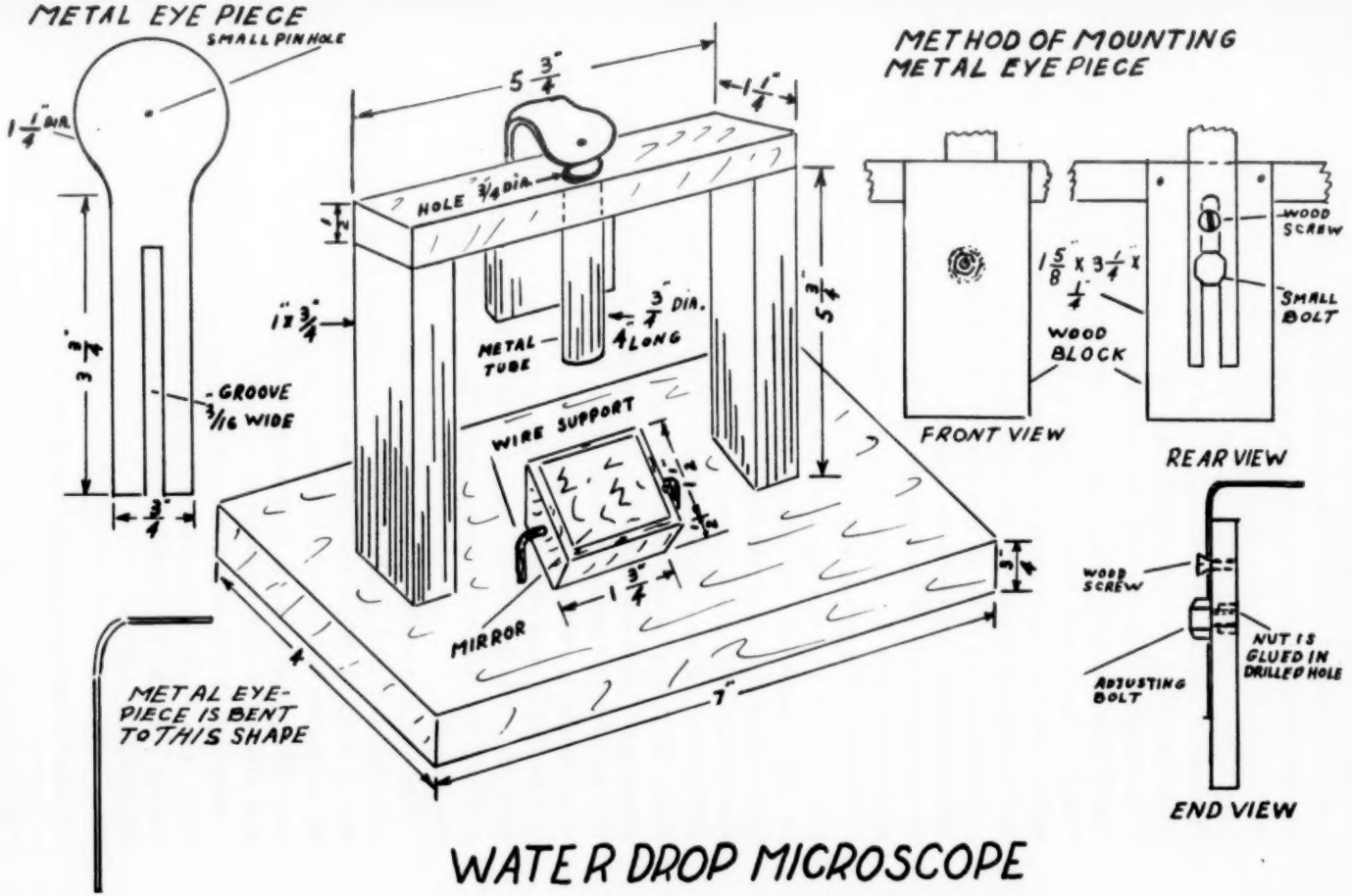
Most every boy or girl at one time or another has expressed a desire for a microscope. For those boys and girls who are willing to exercise a little patience, and careful work, the ownership of a microscope with which to explore worlds unseen to the unaided eye can become a reality.

Before beginning its actual construction, a word or two should be said about the operating principle of this microscope. After examining the diagram carefully it will be seen that this microscope does not have a lens. Our lens in this case is a water-drop placed over a small hole, punched in a metal eye-piece.

Water being transparent has the property of being able to refract, or bend light rays. As a beam of light passes through water it is bent to a degree depending upon its angle of incidence. The optical properties of water are very similar to those of glass. It will be found that the magnifying powers of a drop of water will vary according to the size and shape of the water-drop. With a little practice in the handling of the water-drop this simple microscope will produce magnifications up to 100 diameters.

The materials for building this microscope can be found around any household. The young scientist need not be limited by the suggested materials. That is, the metal tube can be substituted by one made of cardboard, or the eyepiece can be made from tin, brass, or copper. However, the dimensions should be followed carefully, for they have a direct relationship to the success of the microscope.

Now for its construction: The wooden frame which is easily made, can either be nailed or screwed together. The microscope mirror is of the pocketbook variety. It is glued to the small wood block. The wooden block with the mirror is then mounted on a wire support directly beneath the tube. This tube through which the reflected light from the mirror passes, is mounted in the center of the wooden frame. Care should be taken to have the top of the tube flush with the surface of the frame.




# WATER DROP MICROSCOPE

Since the metal eyepiece holds the water-drop, extra care should be taken in its construction. The small hole in the center of the eyepiece is made by using either a small sharp punch, or a nail which has been ground to a needle-like sharpness. If the metal used happens to be soft, a large darning needle makes an excellent punch for this hole. A word of caution at this point: the hole should not measure more than 1/64 to 1/32 of an inch in diameter.

As shown in the drawing the eyepiece is made adjustable by the use of a groove, and a small bolt. The block of wood which carries the eyepiece has a hole drilled through it and is mounted on the wood frame with two small nails. This hole is countersunk on the opposite end to hold the nut of the adjusting bolt in place.

If the various parts of this microscope have been carefully made, and assembled, the observer should be able to look through the hole in the eyepiece and into the mirror. In other words, the eyepiece, metal tube, and the mirror should be aligned with each other.

Now for a few points of procedure for using the instrument. First, practice and experimentation with the size of water-drops used will be necessary before the desired results are obtained. It will also be noticed that the evaporation of the water-drops will be affected by the condition of the atmosphere.

When in use, the microscope should be placed in a good source of light. Most any microscopic slide can be viewed under the water drop lens. I dare say the greatest measure of learning and pleasure will be derived from homemade slides. For a starter, a human hair is an excellent specimen for our microscope. Place the hair in a drop of water on a glass slide. Next place it over the opening of the metal tube. Now tilt the mirror until it reflects the light through the tube and into the eyepiece. Place a small drop of water over the hole in the eyepiece.

The eyepiece with the water-drop is now lowered by loosening the adjusting bolt and gently pushing the eyepiece down until the specimen is in focus. When the eyepiece is in the desired position tighten the adjusting bolt to hold it in place. In most cases it will be found that the eyepiece has to be lowered until it is just a fraction of an inch above the slide in order to bring the specimen into focus.

Although it will take time and perseverance to master the technique, this little microscope will more than repay the efforts of the builder with the many pleasureable experiences it affords through its construction and use.

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What educational meetings did you attend in 1952?

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What professional journals do you take and read regularly?

# CONSERVATION IN WILD FLOWER STUDIES*

MILDRED F. CAMPBELL
*Department of Biology, Shortridge High School, Indianapolis, Indiana*

Wild flowers were disappearing rapidly in a growing city like Indianapolis. Everyone seemed to have a habit of picking flowers. Soon, children would have to look at the picture of a flower or a pressed specimen instead of seeing a living plant in bloom. One would not have the fun of enjoying a walk through the woods, in a bog or along a roadside observing blooming plants. Some of the teachers said that when there were no more flowers to be picked and pressed they would not teach Biology or Botany.

A spring flower record has been kept in calendar form. Year after year this record of the 1st blooms is printed on the blackboard or on a window shade in the class room.

| Date | Name of tree, shrub or herb in bloom | Pupil(s) observing first blooms |
|---|---|---|
| | | |

Each pupil keeps his own record in diary form in a notebook or on 3″×5″ cards. (A student in one of our classes printed the data required on a small card for his personal flower and bird record. He carried enough cards in his pocket whenever he went on a field trip. The word "Activities" was marked out when he described a flower. These printed cards are sold in our high school bookstore.)

3″×5″ card

Date
Weather
Habitat

Activities

Color

Special markings

Size
Common name
Observers

Pupils receive careful instructions for the making of the first observations. Date, weather and the habitat are given first. Most of our

* This article was written on request of the editor. While in charge of the Butler Botanical Gardens I had abundant opportunity to observe the Shortridge students at work in field identification of wild flowers and sketching of the flowers observed. It was a rare case when I could not recognize the flower from the sketch made by the students. It is an excellent method of studying wild flowers without destroying them.—J. E. POTZGER

students draw the bloom life-size showing the number and arrangement of the flower parts and the shape of one or more of the leaves on the stem. The size or the height of the plant observed is important. The teacher is able to aid pupils in identification of plants. After several families can be recognized, many of our pupils enjoy using a key. Many of our pupils carry coloring pencils or crayons into the field in order to match color of the plant.

The first field trips are taken on our school grounds. It takes several days to give adequate instruction before pupils draw or describe a plant and leave it for the next group of students to describe or draw. In case a few flowers are picked and brought into the classroom for identification they can be used for demonstration. They are named and it is decided whether conservation is necessary for a plant brought in without roots. Any wildflower with roots is planted on the school grounds for pupils to observe and draw. Location maps or diagrams are placed on the blackboard as the season progresses.

Notebook records are checked regularly by the instructor. The cards are due in the hands of the instructor as soon as possible after the observation has been made. The plant should be in bloom at the time this card is turned in. The Skunk Cabbage does not bloom in this vicinity in June and therefore can not be accepted at that time. These cards are kept in a file in the department.

Every pupil has a minimum assignment of field work. Most of our pupils go beyond the minimum. We suggest that they double the requirement and then be sure that the student's other classes do not suffer because of this desire to know more families of plants in different habitats.

When this plan of conserving and not destroying plants begins to work in a community householders need not worry about giving permission to young people to sketch a flower. Our pupils have been invited to go on trips to special areas to do field work. We, at Shortridge High School have had happy experiences with our pupils at school and by letter from many parts of the world. It has become a sort of tradition since the days when Miss Rousseau McClellan interested teachers and students in making individual observations out of doors.

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## PINK EYES, WHITE BODY, BUT IT'S A BLACK SNAKE

An albino black snake, with pink eyes and body white as carved ivory, is the new rare specimen in the Washington Zoological Park. Captured by Frank A. Davis of Silver Spring, Md., it was presented to Dr. William Mann, director, who reports that he knows of no other albino snake now in American zoo collections. It is a young specimen, one and a half feet long, and probably of the pilot black snake sort that normally is black with white underneath.

# THE LAWS OF ALGEBRA AND MODERN ALGEBRAS

H. S. CLAIR
*Hyde Park High School, Chicago, Illinois*

Basic to the study of elementary algebra are the so-called Laws of Algebra. These are: the commutative laws of addition and multiplication, and the distributive law. These laws may be stated symbolically as follows:

I. $a+b=b+a$
II. $ab=ba$
III. $(a+b)+c=a+(b+c)$
IV. $(ab)c=a(bc)$
V. $a(b+c)=ab+ac$

In such a system the sum, difference, and product of two quantities of the system are also quantities of the system. A system satisfying these conditions as well as the laws stated above is called a *commutative ring.*

A commutative ring which has the added property that if $ab=0$ then either $a=0$ or $b=0$ is called an *integral domain.* It follows from this that if $ax=ay$ and $a\neq 0$, then $a(x-y)=0$ and $x=y$.

An integral domain in which division is possible by any number except zero is called a *field.* The integers do not form a field, but the rationals, the real numbers, and the polynomials of elementary algebra each form a field.

It is on these laws and operations with them that the ordinary rules of arithmetic and algebra are based. Years of contact with the integers made these laws seem obvious. As we extend the positive integers first to the negative integers, then to the rationals, and finally to the real numbers system, we must with every new type of number prove these laws all over again. The proofs in each case are quite simple and straightforward, and will be omitted here. It is the purpose of this paper to describe briefly several types of "number systems" in which one or more of the above laws do not hold. The true significance of these laws will thus become apparent, and should be helpful to the teachers of arithmetic and elementary algebra.

If in chemistry we take as "numbers" chemical compounds or mixtures and the operation plus to mean "followed by," then

Water+concentrated sulfuric acid

gives dilute sulfuric acid with slight heat of solution, while

Concentrated sulfuric acid+water

may produce a dangerous explosion accompanied by a tremendous

production of heat. Thus the commutative law of addition is invalid in this instance.

A spectacular example of a non-commutative algebra is offered by Hamilton's *Quaternions*. In this system of numbers (an extension of complex numbers to three dimensions) every number is a linear combination of the four "units" $1, i, j, k$, with coefficients in some basic field; say the field of rationals. The four units have a "multiplication table" displayed below:

| | $1$ | $i$ | $j$ | $k$ |
|---|---|---|---|---|
| $1$ | $1$ | $i$ | $j$ | $k$ |
| $i$ | $i$ | $-1$ | $k$ | $-j$ |
| $j$ | $j$ | $-k$ | $-1$ | $i$ |
| $k$ | $k$ | $j$ | $-i$ | $-1$ |

Since $ij=k$, $ji=-k$, $jk=i$, $kj=-i$, $ki=j$, $ik=-j$, multiplication is non-commutative. Nevertheless, quaternions obey all the other laws of numbers. In particular they are associative; for three quaternions A, B, C satisfy $(AB)C=A(BC)$ as can be verified by elementary computations. Similar remarks apply to the remaining laws, excepting that in the distributive law multiplication on the right is to be distinguished from multiplication on the left.

To show that *real* quaternions (quaternions with real coefficients) constitute a division algebra, we proceed as follows: Let $Q=x_0+x_1i+x_2j+x_3k$ be any quaternion. Then the quaternion obtained from $Q$ by changing the sign of the vector part is called the *conjugate* quaternion: $\overline{Q}=x_0-x_1i-x_2j-x_3k$. The product of $Q$ by $\overline{Q}$ is a positive scalar $N(Q)=x_0^2+x_1^2+x_2^2+x_3^2$ which is called the *norm* of the quaternion. Thus every quaternion (except of course, zero) has a reciprocal, since $1/Q=\overline{Q}/N(Q)$.

If complex coefficients are allowed division may fail, for with complex numbers it is possible that $x_0^2+x_1^2+x_2^2+x_3^2=0$ without all the quantities $x_0, x_1, x_2, x_3$ being zero. Complex quaternions therefore do not form a division algebra.

Another remarkable system of "numbers" which have properties very similar to the cardinal integers is the set of residue classes modulo a prime integer. In this system two integers are equivalent if their difference is divisible by the prime modulus. Technically, $a$ is said to be congruent to $b$ modulo $p$ if $(a-b)=np$ for some integer $n$. Symbolically, we write $a\equiv b \pmod{p}$. Thus to modulus seven, $8\equiv 1$, $9\equiv 2$, $10\equiv 3$, etc. We are thus able to reduce all integers to but seven classes modulo seven.* Now, if we identify congruence with equality, and

* The construction of a perpetual calendar is based upon the consideration of such modular systems.

the residue classes with a new type of number, we have here a system which, like the cardinal integers, obey the five laws of algebra, but unlike them consists of only a finite number of elements. Furthermore, it can be shown by the use of Euclid's Algorithm that division (except by the zero class) is always possible, and so the system of residue classes with a prime modulus constitutes a field.

The situation is quite different, however, when the modulus is a composite number. With a prime modulus, if $ab \equiv 0 \pmod{p}$, then either $a \equiv 0$ or $b \equiv 0 \pmod{p}$. But consider now the pair $4 \not\equiv 0 \pmod{12}$, $3 \not\equiv 0 \pmod{12}$; yet $4 \cdot 3 = 12 \equiv 0 \pmod{12}$. We thus no longer have an integral domain as described on page 1, and the process of cancellation as practiced in elementary algebra is no longer valid.

I now come to a system of numbers which is in some ways more unusual than any of the systems considered so far. I refer to the system usually called Boolean Algebra. It is almost one hundred years since the English Mathematician George Boole wrote *The Laws of Thought*. Only in recent years has the true importance of this look become apparent in connection with the *algebra of classes*. This algebra plays an important role in problems dealing with complex electrical circuits, legal testimony, validity of statistical data, mathematical logic, and probability theory.

In Boolean algebra we begin with the totality of all objects called by Boole a *universe of discourse*. This universe consists of various groups known as *classes*. A member of the universe is a member of some class if there is some distinguishing characteristic or property by which it can be determined whether it is a member of that particular class as contrasted to other members of the universe which are not members of the class. In the theory of logic such classes are usually represented by circles. Points within the circle represent members of the class; points outside the circle represent members not belonging to the class, usually referred to as the *complementary class* (Points on the circumference will be ignored in this discussion). Three possible situations may arise as illustrated in the three figures that follow:

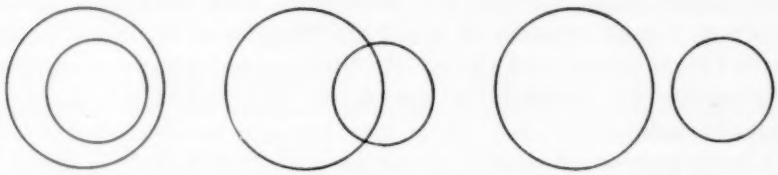

FIG. I FIG. II FIG. III

In Figure I two classes are represented in which the larger class contains the smaller class (or the smaller class is contained in the larger class). It is evident that every member of the smaller class is also a member of the larger class, but not vice versa. In Figure II

some members of either class belong to the other, but some do not. In Figure III no member of either class belongs to the other class.

Now let the letters $a$, $b$, $c$, etc. stand for classes. Then $ab$, the *intersection* or *logical product* of $a$ and $b$, consists of the common parts of classes $a$ and $b$. The *union* or *logical sum* $(a+b)$ consists of all elements belonging to either $a$ or $b$ or both. In particular if $a'$ is the complementary class of $a$, then $(a+a')=u$ where $u$ is the *universal class*, while $aa'=0$ where 0 is the *null class*. Thus if $a$ is the class of all Democrats and $b$ the class of all residents of Chicago, then $(a+b)$ is the class of all Chicagoans or Democrats, while $ab$ is the class of all Democrats who are also Chicagoans.

Let $N(a)$ mean the number of elements in $a$. Then generally $N(a+b)\neq N(a)+N(b)$, for the total of Democrats includes the Democrats of Chicago, and if this is added to the number of residents of Chicago there will be duplication. Equality will result only if $ab=0$, that is unless $a$ and $b$ have no elements in common. In the example above, $N(a+b)=N(a)+N(b)$ if it should happen that no resident of Chicago is a Democrat. In general $N(a+b)=N(a)+N(b)-N(ab)$ as illustrated by our example where the number of Chicagoans and Democrats elsewhere can be found by adding the numbers for all Democrats and all Chicagoans and then substracting the number of Democratic Chicagoans to avoid duplication.

It is not difficult to show that the commutative, associative, and distributive laws of ordinary algebra apply unchanged to the algebra of classes. But $ab=0$ if, as in Figure III, the two classes have no elements in common although neither class need be zero (vacuous). Thus the algebra of classes cannot be an integral domain. Also $a+a=a$, $a\cdot a=a$, and more generally $a+a+a\cdots=a$, $a\cdot a\cdot a\cdot\cdots=a$, since adding a class to itself or multiplying a class by itself will only produce the same class over again. Thus we obtain the bizarre results $na=a$, $a^n=a$ for every rational integer $n$. Of special importance is the *law of absorption*, such as $a(a+b)=a$, since the intersection of a class and a larger class including it is the smaller class.

In recent years systems of "numbers" have been constructed known as *Linear Algebras* of which the Alegbra of Matrices, Grassman's Linear Spaces and Group Algebras are well-known examples.* In these systems neither the associative or commutative laws are generally valid,

A large portion of time in elementary algebra courses is spent in manipulating symbols and gaining mastery of the fundamental

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* See for example A. A. Albert, *Modern Higher Algebra*. Chicago: The University of Chicago Press, 1937, and G. Birkhoff and S. MacLane, *A Survey of Modern Algebra*. New York: Macmillan, 1941.

operations in accordance with the laws of algebra. Failure to apply the laws properly lead to the common "boners" of elementary algebra. The student who derives the identities:

$$\frac{a+b}{a}=b,\quad \sqrt{a^2+b^2}=a+b,\quad (a+b)^2=a^2+b^2,\quad \sqrt{-a}\sqrt{-b}=\sqrt{ab}$$

does not completely understand the laws under which elementary algebra operate. It is the point of view of the writer that an examination of other systems of "numbers" with different laws of operation will lead to a deeper understanding of the usual laws of algebra and consequently to a greater mastery of the subject matter.

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## URANIUM NEEDS EVER INCREASING

By A. C. Monahan

*Science Service Staff Writer*

From Uranium City to Port Radium in northwest Canada is a 500-mile stretch of wilderness of little value in agriculture or forestry, because of its climate, but which some day may provide a plentiful supply of the basic metal needed in atomic energy. This is uranium. It is already being produced in the Port Radium region and Geiger counters indicate radioactive materials far to the south.

Pitchblende, a primary uranium ore, was discovered near Great Bear Lake close to the Arctic Circle a little over 20 years ago and Port Radium established as a mining center. It is a modern village with dwellings that furnish comfort even in the 60-degree-below-zero weather and the almost 24-hour daily darkness that prevails during the winter months. Silver, cobalt, copper and nickel are also mined in the same region.

Uranium City is in the building stage. It is a "boom" town in northwest Saskatchewan just north of Lake Athabaska. It is now the center of wide activities in prospecting for uranium. It is the center where mining claims are filed. In the first day or two after the government filing office was opened on Aug. 4, 1952, some 500 claims were filed. It is estimated that 1,000 prospectors are surveying the general area with Geiger counters. They include trained geologists, old-time prospectors, students and trappers.

Mining pitchblende at Port Radium in early days was to obtain radium, not uranium. The latter was discarded as waste. Pitchblende today, however, is the most important uranium mineral, far more important than the other 100 or so ores in which uranium is known to occur. Radium is what scientists call a decay product of uranium in pitchblende. It was from pitchblende that Madame Marie Curie obtained the first known radium late in the 19th century.

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Engraving machine, especially designed for small weekly newspapers, makes cuts directly from photographs. Burning the picture into a plastic mat with a hot stylus, the table-top engraving machine can produce an 85-screen, four-column halftone in 24 minutes.

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Lampshades with real heather, grass or leaves pressed between sheets of a tough vinyl plastic produce a striking effect in the home. The imprisoned material retains its delicate fibrous structure and can be seen even when the lamp is not on. Dust and grime are wiped quickly from the shades with a damp sponge or cloth.

# EQUIPMENT FOR DEMONSTRATING CONTINUITY IN GEOMETRY

SOL WHITMAN
*Senior High School, New Brunswick, N. J.*

The figures in plane geometry are frequently thought of as consisting of stationary lines, angles, and arcs. So far as most students are concerned, the lines are fixed and permanent, to be changed only for the purpose of creating another exercise. Many students fail to discover the continuous change that takes place in the entire geometric figure as one of its parts is gradually relocated. This is a sin of omission rather than one of commission inasmuch as there can be no finer area for exercising the spatial imagination than exists in continuity demonstrations involving the topics commonly encountered in a typical geometry course. Although some areas are better adapted than others for displaying the concept of continuity, all possibilities for displaying spatial relationships should be explored with the view of replacing static figures with figures that move. Various equipment for such demonstrations can be purchased but much apparatus can be inexpensively made by the students, either at home or in the school shops.

One of the very best devices for displaying continuity with figures that move can be made at home by the students. Most of the students have seen at some time or other the pocket book-movies where the pages are flipped rapidly and a baseball player appears to swing at a ball or two boxers spar in a ring. The students can use the same device to display the movement of the point of concurrency of the three altitudes of a triangle when two sides of the triangle remain constant but the included angle is progressively enlarged. The point of concurrency will be observed to move toward the vertex and pass through the vertex as the angle is gradually increased from acute to obtuse. The superior students might also be interested in comparing in this way the movement of the point of concurrency of the altitudes of a triangle with that of the medians, the angle bisectors, and the perpendicular bisectors of the sides.

This technique might also be used to demonstrate the movement of the vertices of all isosceles triangles constructed on a common base, or to make vivid the various locus problems such as the arc formed by the center of a ladder as the bottom of the ladder is slowly moved away from the base of a building, one end touching the building, the other end being slid along the ground. If the pages are accurately constructed and skillfully fastened together by the students, there is no limit to the number of exercises that can be made to demonstrate effectively geometry in action.

Another piece of apparatus, that can be used to demonstrate the principle of continuity in locus problems involving the ellipse, consists of a plywood board about three feet square and one inch thick painted with dull black paint. Eleven 1/16″ holes, 3/4″ deep should be drilled in the board, one hole in the exact center and five holes, each left and right of the center, one inch apart in a line parallel to one of the sides. Two nails or wooden pegs inserted in the outermost holes will serve as foci for the ellipse. A piece of string with both ends tied to a stick of chalk is then thrown over the pegs. (See Fig. 1.)

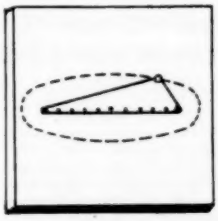

FIG. 1

Moving the chalk around the blackboard while holding it so that the string is stretched taut against the pegs in the outermost holes will produce an elongated ellipse. If the pegs (foci) are made to move toward each other and the experiment repeated, the ellipse will be seen to become less elongated and approach, as its limit, a circle. The circle might then be considered as a special kind of ellipse; namely, the one in which the two foci coincide.

After the entire experiment is concluded, the board can be erased or washed with a damp cloth and thus be made ready for another demonstration.

An additional piece of demonstration equipment can be made quite easily on the reverse side of the "ellipse board" to display the change that takes place in a parabola as the focus moves away from the directrix. All that is necessary is to paint this side of the $3' \times 3'$ board with the same dull black paint as was used on the other side and scratch the board with an awl, so that plainly visible lines appear one inch apart, all parallel to one of the edges which will serve as the directrix. About six or seven small holes should be drilled in this board where the perpendicular bisector of the directrix intersects the parallel lines, and a nail or wooden peg representing the foci of the parabolas can be inserted at varying distances from the directrix. A ruler-like stick marked off in inches with a hole drilled at the zero point can be slipped over the peg to rapidly measure the distance from the focus while the parallel lines will automatically display the distance from the directrix. (See Fig. 2.)

A brief practice period with this "blackboard" will enable the demonstrator to trace a parabola as the locus of a point equi-distant from a given point and a given line in a matter of seconds. If several parabolas are established by placing the peg in the other holes, the student will discover for himself the changes that take place in a parabola as the distance between the focus and the directrix is increased.

The chief value of this piece of equipment is that the ordinary locus problem involving the drawing of a parabola and discussing its various practical applications can be greatly expanded for the superior student in such a short time. Its value is further enhanced by its inherent simplicity, by the ease with which it can be made, and by the fact that the chalk marks can be erased and the board made ready for use in the next class.

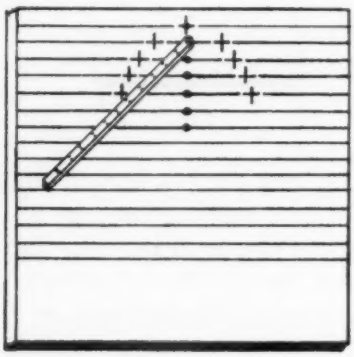

FIG. 2

Another simple demonstration instrument that can be made by any student handy with tools consists of a wooden disk about six inches in diameter and approximately one inch thick with several half-inch holes drilled three-fourths of an inch deep at varying distances from the center. If a piece of chalk one inch long is inserted in the outermost hole, and the disk rolled along the ledge of the blackboard, a cycloid, which is the locus of a point on the circumference of a circle as it rolls on its circumference along a level surface, will be traced on the blackboard.

If the wooden wheel is rolled along the blackboard several times, the demonstrator each time placing the chalk in a hole nearer to the center of the disk, the resulting loci will be observed to produce curtate cycloids which simultaneously become less and less wavy as the chalk approaches the center. It might be well to reverse the experiment and start with the generating point in the center of the disk, gradually moving the chalk toward the circumference. The loci on the blackboad will then be seen to pass from the straight line stage

through the various curtate cycloids and finally become a cycloid when the chalk reaches the circumference. If the instructor desires to further develop this continuity he need only to tape the piece of chalk onto the rim of the disk and repeat the experiment by rolling the disk along a straight line drawn on the blackboard in order to produce the prolate cycloid.

The task of rolling the disk along the blackboard can be facilitated somewhat, by making a handle from a small dowel shouldered down to fit a hole drilled through the center of the disk. This, however, is optional.

Interest in the ellipse, in the parabola, and in the various cycloids will be enchanced if the special uses or practical application of the various figures are noted. The students might suggest the whispering gallery or the elliptical orbit of the earth around the sun with the sun as one of the foci as being interesting applications of an ellipse. The headlight of an automobile might serve to stimulate interest in the parabola.

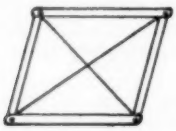

FIG. 3

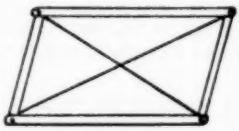

FIG. 4

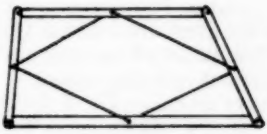

FIG. 5

The cycloidal curve takes on added interest if the students are encouraged to note the remarkable properties of a cycloid such as the length of one arch being equal to the perimeter of a square circumscribed about the rotating circle, or that the area of one arch is equal to three times the area of the generating circle. Some students might even desire to cut cycloids out of wood and place one end of the arch on the floor, the other end against the wall, to observe that if two balls are allowed to roll down the inside of a cycloidal arch, one at the top end of the arch, another ball starting any other place in the arch, they will both reach the bottom at the same time.

Certainly the apparatus mentioned is a suggestive rather than an exhaustive list of equipment that can be used to demonstrate "geometry in action." No reference has been made to the type of model in which rigid sides are fastened together by hollow rivets and the nonadjacent vertices connected with strands of para rubber. This type of equipment can be used to display for any position such propositions as, (a) the diagonals of a rhombus are the perpendicular bisectors of each other (See Fig. 3), (b) the diagonals of a parallelogram bisect each other (See Fig. 4), (c) either diagonal divides a parallelogram into two congruent triangles (See Fig. 4), or (d) the segments

connecting the midpoints of any quadrilateral form a parallelogram (See Fig. 5). Nothing has been said of the numerous possibilities for demonstrating the continuity that exists between the various propositions involving angle measurement. Also, the mechanical gadgets commonly known as linkages offer numerous possibilities.

Unquestionably much can be done by the average geometry teacher with a reasonable amount of mechanical ingenuity to enrich the course by using inexpensive and simple instruments to demonstrate complex ideas.

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## PREDICTS LONG FUTURE FOR NATURAL GAS

Users of natural gas for cooking and heating have long years ahead before there will be a shortage of this convenient fuel, Dr. Gustav Egloff, Universal Oil Products Company, told the American Gas Association. Proved reserves contain about a 25-year supply and new reserves are being discovered each year.

The natural gas industry has been undergoing a phenomenal expansion in the past decade and promises continuing growth into the foreseeable future, he said. Five times as much is marketed now as in 1935, but proved reserves are three times greater. Proved reserves include only those definitely proved by drilling. There are great areas of the United States not yet drilled and there are probably great quantities of natural gas in the continental shelves extending from coast lines far out into the oceans.

Figures given by Dr. Egloff give an estimate of the natural gas in proved reserves as 194 trillion cubic feet. Ultimate reserves are estimated at up to 500 trillion cubic feet. The 194 trillion cubic feet includes free gas not associated with petroleum, free gas in contact with, but not in solution in crude oil, gas in solution with petroleum, and gas in underground storage.

It is important to point out that natural gas has been discovered at a much faster rate than petroleum and natural gas liquids in recent years, he stated. If this trend continues to 1960, our cumulative discoveries of natural gas on a thermal basis will be 55% of the total liquid and gaseous hydrocarbon discoveries, whereas in 1950, they were only 30%. On a thermal basis there is about the same amount of heat energy in our present proved reserves of natural gas as there is in our proved reserves of liquid hydrocarbons, which include crude oil and natural gas liquids.

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## NEW OFFICE OF EDUCATION PUBLICATION

This study reports on the courses in biological science offered in public high schools, enrollments in the course in general biology, and number of teachers of general biology. It covers also organization of the course, nature of the laboratory work, laboratory and supplementary facilities, the equipment used in teaching the course, appropriations for equipment and supplies, and innovations and problems related to the teaching of general biology. The findings are based on data collected for the school year 1949–50 from a representative sampling of the Nation's public high schools.

"The Teaching of General Biology in the Public High Schools of the United States." By W. Edgar Martin. Office of Education Bulletin 1952, No. 9. 46 pages. For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. 20 cents.

Reports and Publications Branch
October 8, 1952

# SCIENCE FOR MODERN LIVING*

E. EUGENE IRISH
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I rather imagine there are nearly as many misconceptions of science as there are of education. I have a strong feeling that most people have a superstitious regard of science as some giant bogey-man inhabiting astral space somewhere, or else a peculiar, conspiring, personally known group of individuals who constitute the great power known as science.

Science is a very amorphous thing. It's very difficult to define it and to describe it. The best dictionaries have a great deal of difficulty, for they must include meanings that are widely different. Science does not consist of Einstein, Millikan, Eddington and great people of that type. Science is going on all around us—in the classroom; in conferences, such as this; in some of our large manufacturing companies; among the technicians in the laboratories of our hospitals; and among the nurses and good doctors in all the offices throughout this country; wherever an engineer is working in a plant, or over his drafting board. Even in our social study groups there are scientists at work—scientists in the management of cities and in the nature of city living. These people are scientists. But, when we talk of the great and awful science that is about to destroy us with its blind inventions, we somehow or other forget that most of us, or a good many of us, belong to the field of the scientists; that it's our sons or our brothers and sisters who are the scientists.

How would you describe and define science? Certainly not by the subject matter. Here are just a few of the areas of science—just a few of them listed: there's pure science, abstract science, concrete science, experimental science, physical science, moral science, mathematical science, historical science, science of government. How many more would you include? All of these are sciences.

Certainly, then, it's not to be distinguished by its subject matter, for there is a great difference between the science of astronomy and biological science. There is a great difference between the chemist in the laboratory of a commercial institution and the historical scientist. There is a great difference between the political scientist and the technician who checks your blood when you enter the hospital. And, yet, all of these people are scientists, and they're all governed by the term "science."

Nor is science to be distinguished by the kind of people engaged in it. Because Eddington, Einstein, and the like, are great, famous

* An address delivered September 5, 1952 at the Johnson County Teachers' Institute, Kansas City, Kansas.

figures, doesn't change them in quality or character or type from this almost totally unknown person who is so vital to you and your health —this laboratory technician. Science includes as many different kinds of people as there are kinds of people. Within any one branch, such as the biological sciences, you will find a complete spread of all the different types you can imagine. Then, what is science, what does it cover, and who are the scientists? This is important for an understanding of the problem and for clarity of our thinking, lest we blame "the scientists" and not know who the scientists really are.

Science is distinguished by a method of procedure called the scientific method, and wherever that method is used, science exists. Wherever an individual is accustomed to using the scientific method in his work, he is a scientist. This scientific method consists of such things as observation of the world or of the particular segment that you isolate for your own purposes; the formulation of hypotheses as to what you expect will happen if you do certain things, hypotheses which arise as a result of observation or curiosity about things or ideas; and then, the experimental testing of these hypotheses, or hunches, as to what will happen. You actually test the situation to see what will happen. And then, you get something which you tentatively identify as knowledge—information, facts, concerning this field of your investigation. You have an experimental truth which you hold out for anyone to test for himself—either to confirm or to change or to deny; on the basis, again, of observation, hypothesis, experimentation, and testing. This is what distinguishes all scientific effort—all scientific effort.

Science is distinguished in the second place by the fact that it attempts to correlate all of the knowledge that the individual scientists accumulate. Science must write laws within the individual field, laws which will cover the various results which the scientists have found to be true. As these results come in, they're classified and categorized and laws are written about them—descriptive laws, which are ways simply of telling you in general what will happen under these given circumstances. And you know that these results will always occur whenever these conditions are presented. Science, then, is a method of procedure, and it's a type of "knowledge." I put knowledge in quotes there, because we're reaching the stage where we will assert that only such things as come to us through the scientific method, or only such things as are tested by the scientific method, will we include within the realm of the term "knowledge." So, science gives us this particular, tested, confirmable type of knowledge. And wherever we have that kind of information, that kind of knowledge, we have science.

What are the objectives of science? They're very simple, I think. Although, they're worth a great deal of consideration as to the results of such simple objectives.

The first, is to find the truth—just to find the truth. The scientist is one who wants the truth. If he is concerned with education, he wants to learn everything he can about this broad field—every aspect of it. If he is studying flood-control, he wants to know as much as is possible about the causes as well as the effects of devastating floodwaters. If he is an anthropological scientist, he wants the story of what took place in the history of the development of this thing called human life. If he is a biological scientist, he wants the truth, nothing but the truth, of the physical organism and what the rules are which will best lead to the development of this thing that we call humanity, and what the truths are which we can find in the lower levels, and whether there is anything running through all of these forms of life—whether there is any truth to be revealed here that would tie them all together. Regardless of what it is, whether it hurts, whether it helps, whether we like it, whether we don't like it, whether it means our destruction or whether it means our salvation, the scientist's job is to find the truth.

The second objective is to formulate laws—to relate these truths so that one has meaning and relevance for another. Those are all the objectives of science, as I see it.

Now, what are some of the values of science?

First of all, as I've indicated, we should have it clear in our minds that this is by all odds the most successful method of getting truth. In some ways it's strange to put it that way, for sooner or later we'll know that this is the only way to get truth. But at this stage, it's by all odds the best way of getting truth. No other method, whether you want to call it inspiration, revelation, intuition, hunch, emotion, or what have you, can produce truth in the way that the scientific method does. That's important, isn't it, for every area of our life—not merely for those men who are working with atoms and molecules; not merely for those people who are studying blood types, and analyzing the story that the blood cell has to tell. But, it's important for the conduct of our government; it's important for the conduct of our educational institutions that we have scientists designed to study education, or the relationships of knowledge to children and adults, in the same way that we have people studying the importance of certain alloys for certain uses. It's important that science, this understanding of it, become a part of our home life, our living together, so that we don't depend in this very important area of our existence on hunches and intuitions which may be very wrong. Slow accumula-

tions of ideas or attitudes untested, uncritically accepted, may be very destructive. If scientific method produces the greatest truth and advance and progress in production, in our understanding of history, in our understanding of ourselves, and in the elimination of disease; isn't it time that scientific method become a part of our home life, and of our educational life, and of our social and political life? This is a great value of science.

Secondly, science eliminates the personal. I believe this is its greatest contribution and its greatest value. It eliminates the personal! This is so difficult to do that we may succeed in it in the particular area where we are trained to be scientific, and be completely oblivious of the rules and the values, when we move out into any other area. This is what is at fault, I think, with a good many scientists—that they have not really accepted their own methods. They use them in their own particular fields. One scientist will use it in his field, and move over into another area of scientific effort and proceed as the savage who never heard of the method of testable knowledge and the elimination of the personal. I know that it's the greatest thing we have to overcome for the establishment or growth of community—to eliminate the personal. It seems at this stage almost impossible. We reject an idea because we don't like it. We refuse to listen any longer, when we hear an idea that hurts us. I try to fashion my teaching on this proposition, and I am most often critized for my failure to do it. People say to me: "You make that statement at the beginning of your lecture, and you'll lose half your class right there. They'll go on sitting, but they will not be listening." And half is a conservative estimate. We don't like certain things, and when we run into those things we don't like we refuse to pursue the investigation any further. We'll build walls. We do this with each other in our families. We do it in our educational communities, and we certainly do it in our civic and business associations.

Science says, "Your personal taste, your personal interest, the thing you like or don't like, has nothing whatsoever to do with this investigation. You will be a good scientist only insofar as you succeed in completely transcending your personal desires. Unless you do it, you're no good in any scientific effort." And isn't it becoming clear that unless we can do this, unless we can achieve this end, we are no good in any human effort? Science has set the ideal, it's established the goal. It's a great objective, it's a new thing. Science not only has said, "This is something to achieve." It has established the method for achieving it! Follow the method and you will come out in the end with the right answers. We can learn from this; we should learn from this. We have to learn from this scientific value.

In the third place, science is cooperative and universal in its nature. It's impersonal, too, in its nature. For not only does the scientist exclude his personal feelings from his investigation, but it doesn't matter who does the work. It doen't matter whether he's a Greek or a German, a Negro or a Caucasian—as long as he does his work. Do you realize there are no lines drawn in science? Great scientists, social and physical, have been Negroes. No one questions the results of their work because they're Negroes. We had got around to having little or no respect for the Italian people, but an Italian helped produce the atomic bomb. We're glad to share with the Germans our scientific knowledge and to take all that they've got to offer. And so with the Japanese. It's as though we were lifted up into an impersonal realm where all the littleness of our human reactions and of our bitterness and of our pride and prejudice were dropped away and we were actually living in a world where a man counted for what he was and for what he could do, not because of any other consideration. This is a tremendous achievement. If we could only take that vision and bring it down into our other life! Even the scientist doesn't do that. He will live this way and think this way in *his* science. But when he moves out of his science he becomes like the rest of us.

It's this impersonality which provides the cooperation, and it's international. Scientists have gone way out beyond the borders of country and nation and class and color. They cooperate with each other. Men who have never seen one another are the closest of friends through their scientific interchange. When a scientist discovers something, unless he happens to be working for himself in a particularly lush sort of commercial way, it's put on the market and he says: "Here's what I've learned. What have you learned?" The American says to the person way over in Australia or India: "This is my observation. Will you test it for me, will you check it, will you let me know whether I'm right or wrong, whether you agree or disagree?" And that goes on all over the world—cooperation—international and impersonal. This is a marvelous achievement, far more valuable than any single invention the scientists have made, far more valuable than any collection of inventions. For, if we have the method, we'll go on inventing from here on; but if we don't have the method, we're lost. Throw out every invention we have; keep the method and the attitude and the desire, and we'll build a new world.

Now, what are some of the failures of science? We have been dealing with some of them as we've gone along—cross references. First of all, its materialism. Science has been very materialistic. There was no necessity for it. Oh, there was an inclination toward it, insofar as the scientific method works best with precise, measurable quantities

that you can isolate in test tubes and cyclotrons, and so on. But there was no necessity for this materialism. And then, there was a great pride in the fact that we were learning so much about our world and about ourselves, that now we were getting more and more power, and this power was all in the material world that we were taking apart. And so then, the scientists began to think there was nothing else but this power which they were discovering and controlling. And seeing no purpose, seeing no vision, having no understanding of any of the other fields of possible scientific effort, they said, "Matter is all." They've gone on that basis until now; until here it is: it's purely a matter of the physical.

This is particularly due to the second evil of over-specialization. We've got to have specialists. We've got to have people in the community to whom we can say, "Go away from us for a while and study this thing." We've got to have people who will take one field and make it theirs and become expert in that field.

But this specialization has led to a kind of isolationism, which is a direct contradiction of the basic nature of science as a cooperative effort. The very nature of science has driven it into an error, which is a violation of its own principle. It happens in more than the field of science—this insularity of men who possess amazing knowledge in some small field, and know almost nothing of what goes on all around them. I'm not sure that the modern world with its terrible interconnectedness has room for people who don't realize the interconnectedness. There was a time when we could afford to let people like that go on. I'm not so sure we can any longer. It seems to me that's an evil.

In the third place is the scientist's lack of social concern. His materialistic inclination and his isolation in a particular area, have both contributed to his lack of social concern. He's been a little scornful of those of us who were not scientific and who didn't have exact data to work on. He's a little scornful of those who can't weigh things and measure them. Then, too, I think he's a little afraid when he gets out into this larger area of human life; for he's safest when he's got the things he knows and the things he can handle about him. Have you noticed how many of these scientists and scholars of this type are so socially immature and so frightened and fearful when they get into groups? There's some meaning in that and some reason for it; for the skills that are necessary for social living are skills that are just as difficult, if not more difficult, to achieve than the skills required for any scientific effort.

This lack of social concern goes on all the way down from some of the big people, who say they don't care whether these things they are

working on are of any value to anybody, to the doctors and the engineers and the technicians, and even the social service workers and historical scientists, who have little or no concern for this great experiment of living together. And how much of an active part do these technical scientists play in the welfare of the government, outside of the contribution they make in their own particular fields of effort? Most of these people will justify their abstention; not merely say that it's not true that they abstain. They justify their abstention! And that, I suppose, is the greater wickedness—or maybe it isn't.

But I am appalled by the lack of social concern of our technical and professional people. Our cities are not being run by such people. Our city affairs are not receiving the benefit and the vision of these people. They are not receiving the result of their scientific training and of the enormous amount of educational effort that's gone into producing them. I'm sure the churches aren't receiving it, and I'm just as sure that it isn't going into our social well-being on a city, state or national level. Isn't that important? That our best-trained people, the people who are trained to find the facts, the people whose objective it is and whose basic principle of operation is impersonality—isn't it significant that these people don't seem to care about how we live together?

The atomic scientists, because of one more door opening which scared even them, are now the ones who are most active in the field of social concern. Maybe the others will come along. Let's hope so. But to all the doctors who are worrying about socialized medicine—and that means, as far as I can determine, *all* the doctors—there's a warning in the behavioral pattern of the atomic scientists that maybe they had better begin to become concerned with how people live and with what people need and with what people want; so that in some of our cities where there's corruption destroying the health of our people, the doctors will speak out for a change, and not be afraid of their professional honor and of the things that the rest of the members of—their profession—will say. And the engineers—wherever there are scientists—they've got to begin to realize that there are people like ourselves who are concerned with the way in which we live together. We need more facts and we need more dedication to the problems of living together.

I've been implying throughout the importance of interdependence, brotherhood, and social life. Every last scientist has been producing evidence, which indicates this interdependence. This is not something that a deeply religious person gets in a revelation. This point of interdependence has been presented to us by the scientists—by scientists in every field. We are interdependent and we cannot escape

it. The biological scientist has been demonstrating our brotherhood, the fact that we belong to each other and that we are all brothers. And the social scientist has been pointing out, as has the anthropologist and the biologist, that we've got to live together in a community; and that from the beginning of life, for instance, there's been a growth of this thing we call our altruism—our concern for the whole even at the expense of ourselves—and that cooperation is a fundamental rule of evolutionary development. Interconnectedness, brotherhood, and social life—these three things science notes, science establishes.

The future of this relationship of science to the problems of day-in and day-out living is one that everyone must face. We must first of all realize that *we* must be scientific. We are the ones who must be the scientists. Your job may be routine, but there is a place in which you can be scientific, and that's in the acceptance or rejection of things that other people who are trained to produce knowledge or facts present before you. You can be scientific in the way you understand your school and your community; you can be scientific in the way you live in your family; and you can be scientific in your teaching. All of these areas are open for you.

We ought to know by now that facts alone will not solve our problems. And yet, it seems to me that the greatest error into which most of us as teachers fall, is in assuming that simply because something is learned, desirable behavior with respect to it follows. To put it another way, mere knowledge of a particular referent does not always preclude favorable behavior with respect to it. I'm using the word "referent" in this case to denote anything—an object, a person, a group of persons, an idea. Many of us know, for example, that eating certain foods is not good for us. We know that. We know it to be a fact. Yet, many of us continue to eat those very foods.

If education is concerned with producing desirable changes in behavior, then perhaps we should ask ourselves this question: "How do you get people to *want* to do the things you want them to do?" How is acceptance of an idea or an attitude effected—acceptance, that is, with understanding?

I realize there are many teachers who sincerely believe that learning is taking place, whenever their pupils have discharged some routine assignment, or whenever they have managed to demonstrate a reasonable competency in some skill. In fact, I know a teacher who prides himself on the basis that he, " . . . makes 'em learn." Now, nobody ever *made* anyone else learn anything. You may think that learning is taking place under such circumstances, but actually it isn't. Strange, isn't it, that the same teacher who says, "I make 'em learn," turns right around and says, "I don't understand why my

pupils forget so much." The chances are that what the teacher thought was learning was so obnoxious to his pupils that they couldn't forget it fast enough—if, indeed, they ever did learn it. So once again, I pose the question: "How do you get people to *want* to do the things that you want them to do?" This is especially important to those of us who are charged with the responsibility of training children.

Assuming that we know what's desirable in the form of a curriculum or program of studies, and assuming that we know what's desirable in the way of attitudes and skills and behavior, how do we get our students to the point where *they* will feel that such things are important and desirable, and that they, too, will want to achieve them? It isn't an easy question to answer, nor is there any one answer that can be made applicable in all cases. The problem simply defies any easy generalization that might cover all situations. But this much we do have; this much we know: science has shown us the way; science has given us the procedure; science has established the method. It's up to us to instill the desire and to inculcate the attitudes.

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## FOURTH EDITION OF RADIO OPERATOR'S LICENSE Q&A MANUAL

John F. Rider Publisher, Inc., 480 Canal St., New York 13, N. Y., announces that the Fourth edition of "Radio Operator's License Q&A Manual," by Milton Kaufman was published in December.

The new edition is in complete accordance with the FCC Study Guide now being used as a basis for radio license examinations. The text has been brought up-to-the-minute, particularly with regard to new operating procedures and new frequencies. Questions which have become obsolete since the last edition have been deleted. Questions have been renumbered to make them conform to the latest Study Guide. Discussions to many questions have been amplified so that the reader may achieve maximum background information.

The method of presentation is clear, logical and completely easy to read. Questions follow those presented in the current FCC Study Guide for radio operator's license exams; the answers are given in a wholly understandable way, followed by simplified discussions of the topics. It is this discussion feature of the book that enables the reader to acquire a more thorough explanation of the question. All eight Elements, which include Element 7 on Aircraft Radiotelegraph and Element 8 on Ship Radar Techniques, are covered fully in this same method.

The volume offers valuable appendices on Small Vessel Direction Finders and Automatic Alarm, which are exclusive with this book.

Primarily designed as a study aid, the book covers all the information necessary for the successful completion of the FCC examinations for radio operators. As a reference volume, it offers a quick, easy-to-locate review of essential theory. The new "back-pressure arm-lift" artificial respiration method is discussed with illustrations. The subject matter is given according to Element, in the same manner as presented on the FCC exams. However, if the reader wishes to study by subject, rather than by Element, the thoroughly complete index enables this procedure to be followed with maximum convenience.

"Radio Operator's License Q&A Manual," Fourth Edition, contains 730 pages in a cloth binding. Profusely illustrated, it is $5\frac{1}{2}'' \times 8\frac{1}{2}''$ in size. It is priced at $6.60.

# BACKGROUND AND MATHEMATICAL ACHIEVEMENT OF ELEMENTARY EDUCATION STUDENTS IN ARITHMETIC FOR TEACHERS

CLARENCE PHILLIPS
*University of Illinois, Urbana, Ill.*

In order to determine the content and method of teaching prospective and experienced elementary teachers, it is essential to know their background and competencies in mathematics. The following is a study of students entering Arithmetic for Teachers at the University of Illinois. Table I shows the distribution of students for which data was available. Note that for certain data a smaller number of students' records were available.

TABLE I. DISTRIBUTION OF STUDENTS

Data for Part II—Mathematical Achievement: Hundred-Problem Arithmetic Test

| | Soph. | Junior | Senior | Graduate | Irregular | Women | Men | Total |
|---|---|---|---|---|---|---|---|---|
| 1947–52 | 1 | 55 | 200 | 7 | 5 | 259 | 9 | 268 |

Data for Part I—Personal background
Data for Part II—Mathematical Achievement: Geometry, Algebra, and Arithmetic Meaning and Understanding

| | Soph. | Junior | Senior | Graduate | Irregular | Women | Men | Total |
|---|---|---|---|---|---|---|---|---|
| 1950–52 | 0 | 14 | 106 | 3 | 0 | 117 | 6 | 123 |

## PART I-PERSONAL BACKGROUND

Thirty-six per cent of the students came from cities of 1 million or

TABLE II. POPULATION OF HOME COMMUNITY

| Population | Per Cent |
|---|---|
| 1,000,000 and over | 36 |
| Suburbs of cities of 1,000,000 and over | 12 |
| 100,000–900,000 | 4 |
| 50,000–90,000 | 6 |
| 25,000–49,000 | 10 |
| 15,000–24,000 | 5 |
| 10,000–14,000 | 2 |
| 5,000–9,000 | 11 |
| 1,000–4,000 | 6 |
| Below 1,000 | 6 |
| Rural | 2 |

over and almost the same number came from cities below 25,000 population. Table II shows the per cent of students coming from various sized communities.

Fifty-five per cent of the students have had no teaching experience. Table III shows the distribution of teaching experience.

TABLE III. TEACHING EXPERIENCE

| Experience | 6% |
|---|---|
| Practice teaching completed | 5 |
| Practice teaching while enrolled in Arith. for Trs. | 34 |
| No experience | 55 |

Relying on the students' memory as to their feeling toward mathematics at different elementary grade levels, it is interesting to note that approximately 17–34 % had a negative or indifferent feeling. As shown in table IV, there is also a slight increase on the negative side as the elementary grade level increases. Limited research indicates that the topics, fractions, per cent, and word problems are often given as the reasons. Of the students who had both Algebra and Plane Geometry in the high school, the latter subject caused a higher negative reaction. Limited research indicates that in the latter subject, the students also received lower grades. In table VIII, the achievement in geometric competencies is also lower than that in algebraic competencies.

TABLE IV. STUDENT REACTION TO MATHEMATICS AT DIFFERENT GRAVE LEVELS

| | 1 dislike or hate | 2 slightly dis-in-terested | 3 indiffer-ent | 4 slightly interested | 5 like |
|---|---|---|---|---|---|
| Primary | 1% | 5% | 11% | 13% | 70% |
| Intermediate | 6 | 7 | 19 | 21 | 47 |
| Upper | 9 | 10 | 15 | 19 | 47 |
| Algebra | 4 | 7 | 8 | 20 | 61 |
| Geometry | 21 | 8 | 8 | 17 | 46 |

The students were asked to list the major reasons for their particular reaction to mathematics as given in Table IV. Forty-two per cent mentioned that the method of presentation was an important factor. Table V gives the various responses.

Almost all of the students have had high school Algebra (98%) and high school Plane Geometry (91%). Table VI shows the background in mathematics subjects.

TABLE V. MAJOR FACTORS INFLUENCING STUDENT'S REACTION TO MATHEMATICS

| | |
|---|---|
| Presentation | 42% |
| Achievement | 29 |
| Teacher's personality | 24 |
| Type of problems | 22 |
| Drill | 10 |
| Absences, transfers, skipping grades | 10 |
| Grading system and testing | 7 |
| Parents | 4 |
| Prescribed method of solution | 2 |

TABLE VI. HIGH SCHOOL AND COLLEGE MATHEMATICS SUBJECTS

| | |
|---|---|
| H.S. Algebra | 98% |
| H.S. Advanced Algebra | 35 |
| H.S. Plane Geometry | 91 |
| H.S. Solid Geometry | 17 |
| H.S. Trigonometry | 18 |
| College Mathematics | 10 |

## PART II-MATHEMATICAL ACHIEVEMENT

The median for the 268 students is 75% on the Hundred-Problem Arithmetic test.[1] The average is 72%. According to the authors of the test, the median in the eighth grade is 62% (manual of directions p. 6). In order to ascertain the level of mathematical competence, an item analysis was made for the various tests. Table VII gives the per cent of students who solved the problem correctly.

TABLE VII. ITEM ANALYSIS OF MATHEMATICAL KNOWLEDGE ON HUNDRED-PROBLEM ARITHMETIC TEST

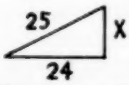
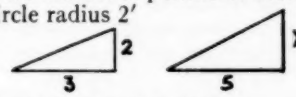
| | |
|---|---|
| 1. Whole numbers | |
| a. Add 7 numbers ranging from 2 to 5 digits | 81% |
| b. Multiply two 3 digit numbers (one of the numbers contains a zero | 78 |
| c. Divide a 5 digit number by a 2 digit number with no remainder nor zero involved in quotient | 72 |
| 2. Fractions | |
| a. Add 3 proper unlike fractions involving fourths to sixteenths | 73 |
| b. Subtract 2 mixed numbers involving "borrowing" | 68 |
| c. Multiply 2 mixed numbers and a common fraction involving halves, fourths, and thirds | 53 |
| d. Divide a common fraction by a whole number | 63 |
| 3. Decimals | |
| a. Divide 4 digit number (involving tenths) by a 2 digit number (involving hundredths) and no remainder | 80 |
| b. Arranging in size (hundredths, mixed number, thousandths) | 53 |

[1] Hundred-Problem Arithmetic Test by R. Schorling and J. Clark. World Book Co., 1938.

| | |
|---|---|
| 4. Fractions—Decimals—Percents | |
| a. Common fraction to percent | 62 |
| b. Mixed per cent to a decimal fraction | 54 |
| c. Per cent to common fraction | 60 |
| 5. Per cent Cases | |
| a. Fractional per cent of an integer | 26 |
| b. Number equals ? % of a number (Ans. 20%) | 45 |
| c. Number equals ? % of a number (Ans. 50%) | 61 |
| 6. Word Problems | |
| a. Simple interest for a year involving integers | 59 |
| b. Simple interest for a year involving mixed number as a per cent | 54 |
| c. Retail discount involving the use of the following: original price minus discount taken off the original price (all integers) | 48 |
| d. Finding the rate of increase with the principal and increase given | 37 |

Mimeographed tests covering elementary topics in Algebra and Geometry were given to the students at the beginning of the semester. Also a test on the meaning and understanding of Arithmetic was given. Table VIII shows the per cent who had the problem solved correctly.

TABLE VIII. GEOMETRY, ALGEBRA, AND ARITHMETIC MEANING

| | |
|---|---|
| 1. Junior high | |
| a. Pythagorean theorem   find $x$ | 23% |
| b. Find the approximate difference perimeter rectangle 4′ by 2′ and circumference of circle radius 2′ | 28 |
| c. Similar triangles   find $x$ | 28 |
| d. Give the formula for the area of a circle | 53 |
| e. Give the formula for the volume of a cone | 9 |
| 2. Algebra | |
| a. $(-3)\ (-2)=$ | 77 |
| b. Solve for $R$; $P=RT/V$ | 61 |
| c. Sketch $x+y=1$ | 18 |
| d. $3x+4y-x+2y=$ | 75 |
| 3. Arithmetic meaning | |
| a. $\$0/3=$ | 30 |
| b. $\$12/\$3=$ | 18 |
| c. By a diagram show the difference between $3\times\frac{1}{3}$ and $\frac{1}{3}$ of 3 | 8 |
| d. Using "24" explain base ten and place value | 24 |
| e. Explain "carrying" in 14+9 | 19 |

In reference to the above data for the students in Arithmetic for Teachers, the following observations may be stated:

1. The students do not come from a specific sized community. Instead, the range is distributed from rural to cities over a million.

2. The four major factors influencing the students' reactions to mathematics are method of presentation, opportunities for achieve-

ment, teacher's personality, and type of problems solved.

3. The elementary and high school mathematics completed gives little indication of the achievement in meaning, understanding, and mechanical mastery. Almost all of them have had Algebra and Plane Geometry in high school.

4. Lack of achievement in mechanical mastery starts with the topic of fractions and continues with decimal fractions and per cent. It is interesting to note that there is a greater negative reaction to arithmetic starting in the intermediate grades.

5. Problem solving achievement involving measurement, fractions, and per cent is very low.

6. There is a higher competence in Algebra than in Geometry. The reaction toward the two subjects favors the former.

7. Achievement in the meaning and understanding of arithmetic is extremely low.

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## RESEARCH GROUP TO OPEN NON-PROFIT EUROPEAN LABS

A cornerstone containing a pure titanium metal "time capsule" was laid in place Friday, Oct. 31, marking the establishment of a new non-profit research center in Frankfurt/Main, Germany.

The research center, costing $1,500,000, is being established by the Battelle Memorial Institute, an endowed research foundation here.

Encased in Indiana limestone, the time capsule will be "virtually everlasting." It represents one of the first examples of successfully welded titanium, said Dr. Clyde Williams, the Institute's director.

Another research center at Geneva, Switzerland, also is to be set up by the Institute. A program of fellowships for selected students in Swiss and German universities already has been worked out, he said.

The Frankfurt laboratories are to help European industry to get back on its feet, to expand productivity and to broaden its markets. Research projects there will draw largely upon European scientists and engineers, although some Americans will be placed in administrative and liaison positions.

The Battelle Memorial Institute was founded to serve mankind by applying science to industrial problems. It currently employs 1,930 scientists, technologists and assistants. This year it will conduct an estimated $12,000,000 worth of research.

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## EXPLORERS MAP FASTER WITH RANGEFINDER

British explorers have speeded up the process of field-mapping unsurveyed territory by using the wartime rangefinder.

Dr. J. V. Harrison, Oxford University geologist, reports that a small party of explorers charted with a high degree of accuracy 10,000 to 12,000 square miles of Iranian wilderness during a nine-month geological survey. Using the rangefinder which allows mapmakers to find the distance of a far object from a single position, the explorers greatly increased the area they could map in a single day.

The older methods of making field maps required two separate sightings from different positions before the distance of an object could be discovered, thus doubling the mapper's job.

Dr. Harrison is now a visiting professor at the University of Illinois.

# NATURE AND CONTROL OF THE POWER THAT EXISTS IN MODERN SCIENTIFIC KNOWLEDGE

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The idea that knowledge is power has long been part of our cultural heritage, regardless of variations concerning the kinds of knowledge thought to constitute power or marked increases in existing knowledge. With respect to further developments in American civilization, particularly its educational agencies, an analysis of the ways in which scientific knowledge is power in modern life deserves more attention than it receives.

A working definition of knowledge might regard it as information or as acquaintance with data. But if a mere possession of facts constitutes knowledge, then an understanding of existing relationships among facts constitutes a different type of knowledge. The manipulation of facts through imagination, to picture relationships *which do not now exist* but *which might exist,* constitutes a third type of knowledge. The further use of imagination actually to rearrange facts in ways which promise desired results, constitutes a fourth type—the use of facts to achieve goals. It is only when the functional situation of type four exists that knowledge has power.

One difficulty in motivating school children to learn is that the knowledge involved often has no practical application that pupils understand. From classmates a pupil may acquire much knowledge which teachers wish he did not have. For the pupil this knowledge is functional and has power. The point concerning function or application relates to various age groups and learning situations throughout civilization. Activities of international spy groups, with efforts to buy or steal trade, military, and scientific secrets—or to torture people into telling what they know, testify to the demand for functional knowledge. This demand has been prominent throughout history. But with respect to the role of knowledge in developing civilization, there are several reasons why it is more important now than ever before to understand the relationship of knowledge to power.

*Power and expansion of knowledge.*—It is useful to differentiate various areas of knowledge and ways in which it has power. One broad division concerns natural and social science—the physical and biological world, and the human-relations world. Increasing differentiation among areas of knowledge and of power results largely from the expansion of knowledge, and from emphasis on making it functional. Even in "basic" or "pure" research, there is hope that somebody will eventually apply the findings so as to increase man's control over nature.

One reason for the present-day importance of the relationship of knowledge to power is the great amount of knowledge that exists now in comparison with former centuries. As items of knowledge increase in number, possible relationships among them increase faster than number of items—because of possible relationships which each new item has to each previous item. There has been a tremendous increase in possible relationships among the facts added to our culture in recent decades.

Along with this recent increase in facts and relationships, techniques and facilities for discovering or creating new knowledge have developed greatly. Through research and experimentation, the facilities and personnel devoted to the discovery of knowledge are rapidly increasing. Somewhat like a rolling snowball, the larger the existing body becomes the larger is the area for new contact and for immediate addition to the body which already exists. Nations with a high level of productivity, relative to necessities for maintaining the group, have more surplus to devote to research and further expansion of knowledge than nations living at the margin of existence—much as families with large incomes (after taxes) have a larger percentage of surplus after acquiring necessities than families with small incomes.

Several important developments are linked to our nation's rapid increase in knowledge and in means of expanding knowledge. One development concerns youth in schools and colleges. When a large per cent of the youth have this educational opportunity, other segments of the population must be sufficiently productive to maintain themselves at prevailing cultural levels and also to provide the surplus needed so these youth can be freed from immediate production and allowed to go to school. A high educational level attained by youth in turn increases their future productive capacity, so that in the next generation an even larger per cent of the nation's production can be devoted to the further development of knowledge and productivity. Some other countries follow somewhat this pattern, but none has gone as far as the United States.

Another American development, related to the rapid increase in knowledge, is the urge that knowledge should not merely be accumulated and "stored" but should be "functional." In part this urge grows out of the fact that *some of the people* in the past who had acquired large bodies of knowledge, and who had reflected on that knowledge, saw many possible implications which did not occur to people whose learning had stopped at merely acquiring facts. Persons who saw these wider implications were impressed with the superficiality and confusion of much learning at the factual level.

Individuals who seek a "moratorium on research and invention," and who reflect nostalgia for the "good old days" when life did not

change much, probably represent social areas at which confusion is greatest. For any cultural group that aspires to a prominent place in future generations, the way out of such confusion is not through moratoriums and retreats but through reorientation in the manner in which we evaluate knowledge. The emphasis of Dewey and others on functional learning, on man's use of facts as instruments for attaining goals, is part of the picture indicated.

The struggle between vocational education and some classical concepts of liberal education, that linger from late medieval days, seems another outgrowth of rapid increase in knowledge. Too many educators and laymen still think of liberal education as in some mysterious way tied up with and confined to the thought and other products that come from certain earlier civilizations in which there was only a small leisure class, and in which that class felt no urge and probably saw little opportunity for directing its thought or other activities into avenues which might ease the burdens of those who did manual labor and who thus provided the privileged class with its leisure. Instead of conceiving of liberal education as consisting of the activities in which a leisure class engaged who already had liberty, in accordance with some current interpretations of what the classical view maintained, a more "functional" present-day conception is that liberal education includes any education which helps liberate an average person from some restraint—from ignorance, superstition, hunger, disease, the fury of the elements, wild animals, pestiferous neighbors, or most anything else from which he might like to be liberated. But if knowledge is to help liberate man as suggested, it must be used with that purpose in mind. Knowledge has liberating capacity only when applied to situations from which one seeks liberation. Applied or instrumental knowledge is commonly thought of as vocational. The fact that in education the continuing struggle between the vocational and the liberal—liberal in the classical sense noted—is gradually but clearly being won by the vocational side, may not be an unmixed blessing. However, if the struggle is primarily on the basis of "either" the classical "or" the vocational, the future of the classical seems dim.

Another development in this country associated with rapid growth in knowledge and relationships, along with requests for moratoriums and urges that knowledge be more functional, is more emphasis on the study of social science. This field attempts to expand knowledge about individual and group associations, and to evaluate different types of accumulating knowledge and power relative to their influence on man. If knowledge is power, then extensive and systematic knowledge about human individuals or groups, should enable persons with that knowledge to exercise power over other individuals or groups.

Systematic knowledge of the psychology of emotion, of why men work, why and how they develop social values and hopes, ways in which self-respect may be developed or undermined and its relation to concepts of social equality, of typical human behavior when afraid or insecure, of ways in which a nation's accumulated reserves in property and other economic wealth can be tied to and changed with a monetary system—these and other types of knowledge in social spheres enable the possessors to extend their power over people who do not possess the knowledge. Hitler showed the world how the development and use of a large amount of social knowledge enables a technological regime to exercise a scope and rigidity of control over people and nations which makes the warriors, priests, money lenders, politicians, and medical men of earlier days seem amateurs.

One aspect of social knowledge deserves further comment—knowledge of how men might cooperate in broad undertakings, recognizing the power of pooled effort and resources. The strength of pooled resources and effort is apparent in business corporations, which are prominent in our nation's economy. It is recognized in the consumer cooperatives which have become prominent in this and other countries. And it is recognized in all our units of government—even though at times different units seem to be in conflict. However with respect to the strength that might lie in widespread international cooperation, the world still needs much additional knowledge.

*Control of the power that lies in expanding knowledge.*—Probably power along any of the lines suggested has been exercised with the idea of its being good—for somebody. The persons most directly benefited have been those in positions to exercise power. However in many instances persons in such positions have not had enough understanding to differentiate between immediate and long-range benefits. Hence the use of power has often led to immediate gains but subsequent downfall of the power groups. The rise and fall through the centuries of political dynasties, tyrannies, and dictatorships illustrate the point. The greed of some money lenders for extension of financial power through usurious interest rates and ruthless foreclosures has led to numerous regulations concerning interest charges and homestead rights. The exercise of a combination of political, military, and taxing power over colonial peoples, in ways in which those people considered unjust and abusive, has led to the disintegration of colonial empires—in both ancient and modern times. Religious leaders have sometimes exercised great power over their followers largely to benefit some church organization and its leaders without great concern for the well-being of followers, but with the result that the organization lost its hold on the following—gradually, or through open revolt. In each foregoing instance it was lack of

insight by those who exercised power which caused their method of using power to lead to their downfall.

Too prominent in such instances is the primitive tendency to annihilate or enslave those under one's power, rather than to realize that the group in power at a particular time can usually prosper more in the long run if it helps develop the productivity and range of interests of those over whom power is exercised. The idea suggested is essentially the democratic idea that the power of government should be exercised *for* the benefit of the people governed. A few industrial corporations and labor organizations are coming to recognize the economic implications of the idea—that neither management nor labor can long prosper unless the other does, and that these two cannot long prosper unless the total economy within which the labor-management groups function is also prosperous.

A recognition of the dependence of each person on the well-being of others, and of each as his brother's keeper, is related to the control of that knowledge which is the basis of power. An earlier comment suggested that persons who can control the knowledge which others acquire can exercise power over those others. This means that when a group is interested in censoring or in otherwise controlling the knowledge which other people get, this group is interested in gaining or perpetuating some power over those other people which it could not exercise if the others had free access to all existing knowledge. Control of knowledge may be exercised through censorship—one form of selection. Control may also be exercised through selecting persons whom society provides leisure for study or economic resources for acquiring materials and physical equipment needed in study. Economic factors regarding who attends secondary schools and universities, or who can afford to travel, are important selective factors.

When there was little knowledge in the world, the mastery or other control of that knowledge did not give the controllers much power over their fellowmen—there were not many things which the controllers could do because of this knowledge which the general run of people could not do. But when great bodies of knowledge exist, and when this knowledge has been organized in various ways to facilitate learning, use, preservation, or censorship, control may be exercised at many points—i.e., control regarding what is included and how it is organized. In a complex society which needs many types of social regulations, there are many points at which corruption in government can appear—where the flow of justice to average persons can be interrupted or misdirected. The same applies concerning the availability of knowledge—in a world in which there are many more facts and possible relationships than one person can master. With the process of organizing, deleting, and emphasizing that accordingly be-

comes necessary, much censorship is possible—apart from directly setting aside large organized bodies of knowledge on "forbidden lists."

While it is obvious that no person can master all the knowledge of any modern society, it should also be obvious that if the general run of people are to be free they must have access to any of the existing knowledge which their interests dictate and their energies permit them to acquire. This view dignifies individual personality by assuming that the individual adult is in the long run the best judge of what knowledge is of greatest interest or of most importance for him to acquire—with the time and energy available. When abundant knowledge exists, the monopoly of that knowledge by a small group is likely to result in the exploitation by that group of the remainder of society. Through wars or similar activities the monopoly group may use other members of its own nation for foreign conquest. This is a common practice for dictators. Hence it is a vital goal of the common people, in countries in which the masses have considerable individual freedom and seek to expand that freedom, to achieve an ever increasing accessibility by all social classes to existing knowledge. Equality of access to knowledge is essential for an opportunity to share equally in directing the power associated with knowledge. For the common people to have assurance of freedom, at a time when power is growing in every direction, they must develop a sound basis for an ever increasing and never failing confidence in their capacity to master and evaluate facts and relationships.

*Future regional significance of the power of modern knowledge.*—During the past century the scientific and technological developments of Western nations have created a level of material existence that is not known elsewhere, with the partial exception of Japan, and that previously was not known in the West. These developments have enabled West Europeans and their cultural descendants to exercise power over the native populations of many lands—in America, Africa, Asia. North America seems to have been "taken over" most completely by these European descendants, biologically and culturally, with perhaps South America and Africa following in this order, and with Asia least affected—except for parts of the eastern island periphery.

There has been great variation in the ways in which Western technology has influenced other peoples. Among factors causing variation are the periods in history concerned, and the application at later times of experience gained in earlier times. The result in most of North America has been an absorption—and—elimination of native Indian peoples and cultures. In Middle America and most of South America, where incoming groups were small relative to the native population

and where the native people had a fairly high cultural development, there has been more biological and cultural amalgamation of native and incoming groups. In most of Asia and Africa the West European descendants have been primarily a trading, military, and governing veneer. The density and cultural development of native populations have been important in this connection—especially in Asia.

Through contacts with the West, the Orient is beginning to understand the power which exists in knowledge of science and technology. This was first reflected by Japan. During the last quarter century it has been increasingly reflected by China and India, and since World War II it seems apparent in Indonesia. Because of the number of people involved, these developments are important for the future. Earlier paragraphs reiterated the idea that the power of knowledge accrues to persons who possess the knowledge. Then if a large number of people possess a high level of knowledge—including knowledge of how to work together in using other knowledge, these people might be expected eventually to possess more power than a small number of people who individually are in possession of about the same kind and amount of knowledge. Pertinent too is the idea that as the information, skills, and techniques of a people become highly developed through science and technology, the population in whom the skills, etc. exist constitutes the greatest resource of the group—greater than the oil, minerals, timber, etc., in the geographical area which the group occupies. This suggests that if the total knowledge of the world continues to increase, with improving facilities for disseminating knowledge throughout the world, the densely populated areas of the Orient are likely to gain in power more rapidly than most other areas. Whether the potential power of the Orient is so great that the well-being or even the existence of cultural groups elsewhere will depend on the action of Orientals, may be an open question. Much will depend on the degree of unity developed among different oriental peoples, as well as on that developed among peoples elsewhere, and on the extent to which unity in either case is based on a voluntary cooperation of diverse groups in contrast with an extermination of those who differ.

It is probably in a setting such as that decribed that the attitudes which a country like India or Indonesia develops toward the United States, or toward the West generally, have their greatest implications. Because of antagonisms and struggle among the nations which now possess extensive scientific and technical knowledge, these nations will increasingly offer this knowledge in their competitive bidding for the support of oriental countries. When knowledge is regional political power, because of its abundance in some countries and its scarcity in others, and because of its value in trade and exchange, knowledge

will be an important tool in future struggles for the minds and loyalties of men. Attitudes and loyalties of the receivers of this knowledge will be greatly affected by the sources from which it comes, as well as by the censorship, propaganda, and general attitudes with which it is made available. At present, President Truman's Point 4 Program constitutes this country's best organized effort to help countries like India secure knowledge of the type suggested. This does not mean that Point 4 is now or should become the only American effort in the direction indicated. More needs to be done through both governmental and other avenues. With the prominence of the United States in world affairs, and the influence which this country could exert through examples reported or through direct contact, the next few decades might show a marked spread of the American faith in science and in experimental methods of determining truth.

One point should be added. Since it is only in functional knowledge that there is power, technologically advanced countries should realize that much of their scientific knowledge needs simplification before people in technologically backward countries can understand or use it. It is important to differentiate between the native population understanding and applying knowledge, and a group of American or West European technicians making the applications *for* the native peoples. In the latter case the natives are lost and unable to help themselves when the technicians leave—lost through inability to repair complicated machinery, to develop crop-rotation or soil-fertility programs, or to maintain modern health and sanitary equipment. For example it might offer more help for the agriculture of India to help Indian farmers develop better ox-drawn plows than to bring in tractors with three-bottom plows. In China we apparently made the mistake of introducing complicated machinery, which the Chinese were unable to keep in repair and operation without our technicians, while our Soviet competitors gained ground through simpler appeals to the undeveloped knowledge and imagination of the Chinese people. The same error could be made elsewhere in the Orient.

What many of these countries need *first* is science at the junior high school level, rather than the science of the graduate school or industrial laboratory. The mistake here is the same as that in much science and other teaching in American schools. Although there has been substantial improvement during the past quarter century, much teaching in our secondary schools is still organized according to the specialized and abstract concepts of graduate schools rather than according to patterns which reflect applications in the daily lives of typical adolescents. Some clues on giving functional knowledge to peoples who are essentially illiterate in the scientific and technological sense, may be found in procedures for *stepping-down* the specialized

science of advanced students to suit the backgrounds of adolescents. A similar problem is involved in making science understandable to many lay adults in this country. However during the past few decades considerable progress has been made in the direction indicated—partly because scientists have become concerned about the actual and potential rebellion against the economic demands and some of the practices of a science which laymen do not understand, and partly because of research in Education on how children learn and on the organization of subject matter to facilitate learning. If potential rebellion of this kind lies below the technological surface in this country, in a substrata of ignorance regarding science, the corresponding potentialities would seem much greater in India or Burma—where the general ignorance is greater, and where the science and technology would have the additional handicap of suspicion because they are "foreign."

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## ON THE GENERALIZATION OF SIMPLE SCIENTIFIC PROBLEMS

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This paper is designed to highlight the importance of generalizing the features of simple scientific problems and striving to secure general results. This procedure of generalization is not only of great pedagogical importance, but also represents an important aspect of genuine scientific endeavor.

I shall here attack a simple problem which occurs in science and, in so doing, shall take opportunity from time to time to point out some of the benefits to be derived from generalizing simple non-trivial problems.

I take as an example a problem from page 256 of *General Chemistry*, by Linus Pauling. The problem reads:

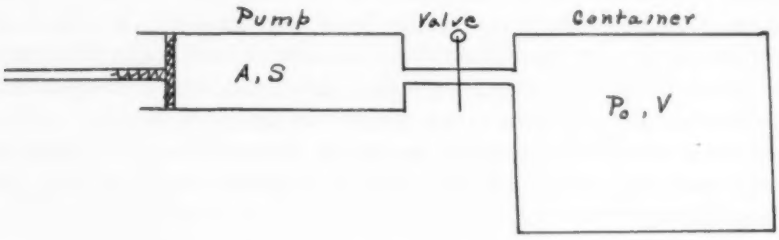
> The volume of an ordinary hand-operated bicycle pump is about 0.01 cubic feet; that of a bicycle tire about 0.06 cubic feet. At what point in the stroke of the pump does air start to enter a tire which is at gage pressure of 47 pounds per square inch? Does the pressure in the tire change more per stroke when the tire is at gage presure 50 pounds per square inch than at 20 pounds per square inch?

Since we recognize that this is not an altogether trivial problem, we state the problem in more general terms rather than work it as it stands. Our problem will now read something like this:

GIVEN: A container of volume $V$, filled with air at pressure $P_0$; a pump with stroke volume $S$. (Let $A$ stand for atmospheric pressure.)
FIND:
a) at what point in the stroke air starts to enter the container;

b) $P_1$, the pressure in the container after one (1) stroke of the pump;
c) the relationship between the change in the container-pressure per stroke and the original pressure in the container.

We idealize the problem to a certain extent by neglecting any losses due to leaks and assuming that the temperature is constant throughout. Since a figure will help us think about the problem, we draw a figure something like this:




Assume the valve is closed for the moment. Now, in order for air to pass into the container, the pressure in the pump must reach $P_0$. We first compute the volume (a fraction of $S$) to which the air in the pump must be compressed in order that the pump pressure be equal to the container-pressure. We use Boyle's law, $PV=K$, where $P$ stands for pressure, $V$ stands for volume, and $K$ is constant. Thus we may write

$$P_iV_i=P_jV_j$$

where the subscripts denote different states or conditions in the container. Thus, for equilibrium, the pump volume must be compressed to a value $(XS)$, where $0<X\leq 1$, and $X$ can be found by using Boyle's law. Hence $AS=P_0(XS)$, which says $X=A/P_0$. We have thus, in effect, answered part (a) of the problem.

We proceed to part (b) of the problem. We have an amount $(XS+V)$ of air at pressure $P_0$. We wish to open the valve and compress this amount to the volume $V$ and then find the resultant pressure $P_1$. Again we use Boyle's law, where this time our unknown is a pressure $(P_1)$, while in the earlier problem the unknown was a volume $(XS)$. We have $(P_0)(XS+V)=(P_1)(V)$, from which it follows that

$$P_1=\frac{AS}{V}+P_0. \tag{Ia}$$

This is the answer to part (b). By way of *checking* our result, we note that all the data appear in the answer; also we notice that the dimensions or units of the answer check, *i.e.*, we have an equation which says "pressure equals pressure."

Now to part (c) of the problem. Letting $(\Delta P)$ stand for the change in the pressure inside the container, we see that

$$\Delta P = P_1 - P_0 = \frac{AS}{V} = \text{a constant!}$$

That is, $\Delta P$ is not a function of $P_0$. Thus an important part of our problem has been answered in general terms: The change in container-pressure per stroke is *not* a function of the original pressure in the container. This general observation *we would have missed* had we not proceeded to solve the problem in general terms. Also, if we had worked only the special case originally given us, we would have lost our opportunity for convenient checking of our results.

We can now make *further observations*. Our work up to this point enables us to observe that after $n$ strokes of the pump, the pressure in the container has increased by $(n)AS/V$, or, in general,

$$P_n = \frac{nAS}{V} + P_0 \qquad \text{(I)}$$

where $P_n$ stands for the pressure in the receiving container after $n$ strokes.

We can now, for instance, generalize the meaning of the formula for $P_n$ to the case where the gas in question is not necessarily air supplied from the atmosphere, but a gas supplied from a container in which the pressure is maintained at a constant value, $A$.

But this easily gives rise to a *new problem*, which is, it turns out, primarily *of mathematical interest*. Suppose the pressure in the supply container is *not* maintained at its original value. Let the supply container be a closed container. What would be the pressure in the receiving tank after $n$ strokes under these conditions? In order to work this problem, we let:

$A_0$ = the original pressure in the supply tank
$P_0$ = the original pressure in the receiving tank
$U$ = the volume of the supply tank
$V$ = the volume of the receiving tank
$S$ = the stroke volume of the pump.

We assume that the very first action of the pump is to remove gas from the supply tank. The pressure in the receiving tank after one stroke is $P_1$, where, by our earlier result (Ia),

$$P_1 = A_1 S/V + P_0,$$

where $A_1$ is the pressure of the gas in the pump at the end of the first intake stroke. Similarly, we define $A_i$ to be the pressure of the gas in the pump after the *i-th* intake stroke.

We may now write:

$$P_1 = A_1 S/V + P_0$$
$$P_2 = A_2 S/V + P_1$$
$$\cdots\cdots\cdots$$
$$P_n = A_n S/V + P_{n-1}.$$

Thus it follows that:

$$P_n = A_n S/V + A_{n-1}/V + \cdots + A_1 S/V + 1,$$

or,

$$P_n = \frac{S}{V} \cdot \sum_{i=1}^{n} A_i + P_0. \qquad \text{(II)}$$

As a *check* on this result (II), we notice that if, as in our earlier problem, $A_i = A$, $i = 1, 2, \cdots, n$ (*i.e.*, the supply is maintained at a constant pressure), then

$$\sum A_i = (n)A$$

and (II) becomes

$$P_n = \frac{S}{V} nA + P_0.$$

This, we note with pleasure, is the same as our earlier result (I).

All that now remains is the evaluation of the sum $\sum A_i$. This we accomplish by using Boyle's law once again, letting $A_0 = P_i$, $U = V_i$, $U+S = V_j$, and the unknown $P_j = A_1$. We then find that:

$$A_1 = A_0 \frac{U}{U+S},$$

and similarly find that

$$A_2 = A_1 \frac{U}{U+S} = A_0 \left(\frac{U}{U+S}\right)^2$$
$$\cdots\cdots\cdots$$
$$A_n = A_0 \left(\frac{U}{U+S}\right)^n.$$

As a quick check on this result, notice that $A_n \to 0$ as $n \to \infty$, which must be the case since the supply tank is being evacuated.

If, for simplicity, we let $R = U/U+S$, we have

$$\sum A_i = A_0 R + A_0 R^2 + \cdots + A_0 R^n,$$

a geometric series (!) having the sum:

$$(A_0R)\left(\frac{R^n-1}{R-1}\right).$$

Using this result, we have, after simplification:

$$\sum A_i=\left(\frac{A_0U}{S}\right)\left[1-\left(\frac{U}{U+S}\right)^n\right]$$

and, substituting this result into (II), we have

$$P_n=A_0\left(\frac{U}{V}\right)\left[1-\left(\frac{U}{U+S}\right)^n\right]+P_0. \qquad \text{(III)}$$

It does not take a great deal of experience in science to know that the *checking* of a result can often lead to instructive and gratifying observations. Such is the case in this instance.

CHECK No. 1: All the data appear; $A_0$, $P_0$, $U$, $V$, $S$.

CHECK No. 2: The units (*viz.*, pressure) of our answer are correct.

CHECK No. 3: Since $(U/U+S)<1$,

$$\lim_{n\to\infty}\left(\frac{U}{U+S}\right)^n=0,$$

and hence

$$\lim_{n\to\infty}(P_n)=A_0\,\frac{U}{V}+P_0. \qquad \text{(IV)}$$

Does this check? This limit means that *all* of the gas originally in the supply tank has been pumped into the receiving tank. This we can verify by evaluating (IV) in another way, namely, by considering the supply tank as a pump, the whole contents of which is put into the receiving tank in one stroke. We thus use formula (Ia) again, where

$S$ becomes $U$
$A$ becomes $A_0$
$V$ becomes $V$
$P_0$ becomes $P_0$
$P_1=P$, the unknown pressure $(P=\lim_{n\to\infty}P_n)$

Then, $P=A_0(U/V)+P_0$. It checks.

Now for some *concluding remarks*. We note that in our zeal to pursue general results, we have almost forgotten to work the particular problem which started this chain of reactions. But, as is happily the case in these circumstances, if we were able to make these general, more inclusive observations, we can hardly expect to have any diffi-

culty in working out the answer to the special case. This brings me to a point which I consider a most important point for teachers of mathematics.

The point concerns what we might call mathematical mission work. (!) In my experience it has happened repeatedly that students of chemistry and physics and engineering, who have come to me for help in their studies, have apparently been unaware of an exceedingly important characteristic of scientific work, *viz.*, *the general treatment of problems often confronted* in their field. To be sure, they have been exposed to "formulas," but have failed to take into themselves the *frame of mind* which leads to the derivation of meaningful general results. This is an *attitude* and it is properly to be emphasized in the mathematics classroom. If we, as teachers of mathematics, stress this attitude, we may give our students the chance to become their own teachers and thus enable them to enjoy their field of study a great deal more.

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## TREASURY-SPONSORED SCHOOL SAVINGS PROGRAM ADVANCING

Last Fall the Treasury's Savings Bonds Division conducted a special campaign to enroll more schools in the School Savings Program, to increase the number of our young citizens receiving training in thrift and the wise use of personal resources.

The campaign was very successful. The national goal of 3,000 more programs was topped; 5,815 new programs were established, for 194 per cent of goal.

During the first semester of this school year, the Savings Bonds Division is conducting another School Savings campaign. The goal is not in terms of schools, but in terms of students to whom School Savings will become available.

Each state Savings Bonds Office has undertaken to make School Savings Stamp Day available to a minimum of 15 per cent of its total school enrollment. States already having achieved that goal expect to add to their past record an additional 5 per cent of the state's school enrollment. This is expected to result, by the end of 1952, in 5,000,000 students able to take advantage of Stamp Day, for the purchase of Savings Bonds as their personal thrift program.

School Savings has been on the uptrend the past three years, as evidenced by Stamp sales. Stamp sales for the school year 1949–50 were $10,800,000; for 1950–51 were $11,600,000; and for the school year 1951–52 were $14,000,000.

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## FLASHING LIGHTS CUT ACCIDENTS

Flashing lights spotted 500 feet from street intersections here have cut traffic accidents sharply by warning motorists that the traffic light ahead says to "stop."

Synchronized with the traffic light at the intersection, the flasher begins blinking its warning seven seconds before the traffic light turns yellow. It continues to blink until five seconds before the traffic light turns green. A nearby sign warns motorists to be ready to stop if the flasher is working.

Only two rear-end collisions occurred in the southbound traffic lane of one road which was equipped with the warning flasher. But 33 occurred during the same period on the road's northbound lane which was not equipped with the blinking light.

# FISH FOR FUN OR FINANCE

B. Clifford Hendricks
*457 24th Avenue, Longview, Washington*

It is reported, from Edwardsburg, Mich., that David Quinn, Jr., was "pinched by a pickerel." He was ice-fishing when his two companions heard his lusty yell. When they turned to exclaim "What the . . . " they found a four pound pickerel hanging tenaciously on to David's leg. It took him and his two companions several minutes to pry the fish loose. It had leaped and grabbed Quinn's leg as he hauled it through the ice.

## Fishing Fashions

Ice fishing is not the fashion in the northwest. However, there are some unusual ways of fishing practiced now and in the past in this part of the world. The big idea is to get the finny fighters from their watery lair.

Possibly the most publicized unusual "fishing fashion" is that used by the Indians at Celilo Falls on the Columbia. These redmen, for many generations, have dip-netted the up-stream salmon as they leap to get above the rapids. Instead of dipping into the water for the catch they get the fish in the air as it makes the leap to clear the rapids. A huge dam is now in process of construction at Celilo. This was not started, however, until provision had been made to make-up to those Indians for their lost fishing rights.

An interesting section of Justice William O. Douglas's book, *Of Men and Mountains* repeats his conversations with a Yakima Indian fisherman. This man did not net his catch; he speared it. The spear was "made of fir, about four feet long. . . . A bone, perhaps four inches long, with sharp point and barb, fitted snugly over one end of the spear. But the bone is detachable. A leather thong, tied, one end to the bone the other to the shaft, held the bone when it was detached. . . . (When using this spear) he stood as motionless as a statue on the edge of the pool . . . the spear poised in his right hand. . . . (Suddenly there was) a flash in the pool. The spear struck. The next thing I knew the Indian had both hands on the shaft of the spear (which had never left his right hand) lifting a (thirty pound) salmon out of the water. The bone, which was in the salmon beyond the barb, had detached itself from the spear. The weight of the fish was on the leather thong that hung from the shaft." The judge tried that pattern of fishing but found it very difficult to make a hit. The water's refraction required a skill acquired only after much practice.

The modern sportsman usually relies upon casting or the less excit-

ing plan of "still fishing" using either live bait or commercial-mechanical lures. The confirmed angler will talk long and even emotionally on how to cast and the best lure to use.

Commercial fishermen use what might be called less personalized ways of getting their harvest. Some use seines, i.e., nets, often 2000 feet long, capable of being set to depths 200 to 300 feet. Others use a trawl net of about 100 feet length, which they drag on or near the bottom. This net is sack-shaped with an opening in the direction of its motion. The other end is closed. The most widely used method is called "gill-netting." These linen-twine nets, 1200 to 1500 feet long, are set at right angles to the direction of the river's current. The fish swimming up stream get enmeshed in the net so the fisherman finds them caught when he makes his haul.

## Big Ones Do Get Caught

Not all the big ones get away. How big, of course, depends upon what kind you are after. Very few can compete with the 700 pound sturgeon caught by a Yakima Indian at Dalles, Oregon in 1951. This fish was more than eleven feet long and provided 576 pounds of meat for its captor. Its age was estimated to be between two hundred and four hundred years.

A seventy-four year old grandmother at Brownsville, Texas, on August 15, 1951, brought a 162 pound tarpon to shore. It was said to be the largest ever caught in Texas waters. To demonstrate that her catch was not an accident she beached another big one, weighing 118 pounds, only two hours after her first big catch.

The big fish of the northwest, aside from sturgeon, are usually the Chinook salmon. These are said to average about twenty-five pounds. The winning catch of the Olympia, Wash. 1952 Chinook derby weighed 46 pounds. Its captor was Helen Senff.

Derbies are, for the northwest, a sort of fish marathon in which the winner is the member making the biggest catch. They are very commonly salmon derbies though one town on the Washington Pacific coast staged a shark derby. By agreement between Washington and Oregon state authorities, the fifteen days between August 26 and September 10, is declared a closed season for Columbia River commercial fishermen. However, private fishermen are free to continue their fishing. By this means a larger proportion of the fall salmon get up the river to their spawning grounds. It is during this fifteen day period that many of the derbies occur.

## The Dam Damage

When a fisherman finds "thousands of dead Chinook salmon" near a power dam (Bonneville) he is likely to "blame (their loss) . . . to

that dam." Especially when "You find more as you get closer to the dam."

Washington State Department of Fisheries plans to spend $100,000 in 1952–53 for stream improvement work on the lower Columbia watershed. This is a "dollar and sense" recognition of the need to protect fish in their travels up stream to their spawning grounds. This work includes the removal of "splash dams, blasting of cascades, construction of fish-ways and removal of log jams. All to make spawning and rearing grounds accessible to salmon." This is only a part of the longer range program which is to be completed by 1957 and will cost around $1,500,000. It will have "opened approximately 300 miles of productive stream not previously available to migratory fish or barred to them by long-standing man-made obstructions."

## Small Smelt

When "An estimated 1,000 boxes of smelt—50,000 pounds of tiny (five and one half inch) food fish—(are taken) from (two rivers)" in a period of less than eighteen hours it is obvious that it was not by "hook and line."

Two methods are used to take them from the rivers in such numbers: gill-netting and dip-netting. The second is the favored practice since it does less damage to the fish "that get away." How many per dip for the private fisherman may be judged by the remark made by an experienced member who said, "This run is so good that two dips can easily get your limit (twenty pounds)." He was speaking of the Cowlitz river run of 1952.

Smelt runs are of brief duration; a week more or less. Sea gulls often herald their approach. The populations of the runs vary from year to year. Assuming "the catch" (commercial) to be an index of run-quantity the following become indicative of that annual variation. These are all for the same fishing grounds. In 1945 the catch, in pounds, was, roughly, 5.6 millions; in 1946, 3.3 millions; 1947, 1.5 millions; 1948, 4.0 millions, 1949, 3.3 millions and in 1950, 1.4 millions.

A commercial fisherman, in answer to, "What use is made of these millions of pounds of smelt?" answered, "We fish for the fresh market and catch only the amount of fish that is ordered by that market."

## Fishing for Fun

There are, of course, many sorts of fish other than salmon, smelt and sturgeon. Commercially, shad, tuna, halibut and "bottom fish" including cod, sole, perch and flounders, rate for attention. For the sportsman there are many different trouts as well as bass, carp, perch and even catfish. Do they get caught? For one week, three lakes near

Longview, Washington reported: 1000 fishermen with a catch of: 4,754 perch, 1876 trout, 733 crappies, 312 sunfish, 234 bass and 86 catfish. It would seem that "Fishing was good and fishermen plentiful."

### Fish for Finance

Royal Toner, president of the National Fisheries Institute recently stated, "All (Alaska's) gold and minerals together do not compare with the wealth (its) . . . fishing industry has brought to this country." He considers "The future fishing rights in oceans of the world more important than land rights." He heads an organization representing a two billion dollar industry that employs more than 550,000 men and women. The state of Washington's over a million dollar budget for protecting and conserving her fish resources testifies to her faith in fish's future in her economy.

### "The Game's the Thing"

For him who follows fishing as a sport the finance comes principally for outlay rather than from the contents of his creel. His reward is not to be measured in dollars and some seem to think "not in sense." In Judge Douglas' esteem the fisherman gets the greatest thrill when the trout strikes so that he is lip-hooked with a chance to get away. Then "The game's the thing with victory going to the one (fish or man) most skilled." Speaking of a particularly memorable trip he says, "I was too tired to describe the beauties of the scenes I had witnessed on my trip. But the memories of (that) journey were so poignant that I laughed out loud when a friend, who prefers a soft chair by the fire, said, 'So you rode twenty miles of rough trail for six trout'?" . . . Another sportsman put it, "What every fisherman learns, soon or late, is that a full heart is better than a full creel."

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### CIGARETTE SMOKE TAR FOUND CANCER-PRODUCING

Tar from cigarette smoke will produce cancer in mice when painted on the skin over a period of about a year, Drs. Evarts A. Graham, Ernest L. Wynder and Adele B. Croninger of Washington University School of Medicine, St. Louis, and Memorial Center, New York, reported to the National Academy of Sciences.

A connection between cigarette smoking and lung cancer had previously been reported by Dr. Graham and by English scientists. These statistical studies, Dr. Graham said today, showed that in cases of cancer of the lung there is almost always a history of excessive cigarette smoking for a period of at least 20 years and that it is rare to find a case in a non-smoker.

Lung cancer, he pointed out, has increased so much in frequency in the past 40 years that it is now the most common internal cancer in the male sex.

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Wide-angle lens for aerial cameras has been developed for the Air Force. Practically distortion-free, the lens covers more than a 90-degree field and produces much finer image detail than previous wide-angle lenses.

# PROBLEM DEPARTMENT

CONDUCTED BY G. H. JAMISON
*State Teachers College, Kirksville, Mo.*

*This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.*

*All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor* should have the author's name introducing the problem or solution *as on the following pages.*

*The editor of the Department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to G. H. Jamison, State Teachers College, Kirksville, Missouri.*

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## SOLUTIONS AND PROBLEMS

**Note. Persons sending in solutions and submitting problems for solutions should observe the following instructions.**

**1. Drawings in India ink should be on a separate page from the solution.**

**2. Give the solution to the problem which you propose if you have one and also the source and any known references to it.**

**3. In general when several solutions are correct, the ones submitted in the best form will be used.**

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### Late Solutions

**2314, 5.** *Victor H. Paquet, Milwaukie, Ore.*

**2317.** *Proposed by Norman Anning.*

If $f(x)=x(x-1)(x-2)$, solve for $x$, the equation $4f(x)+4f(x+1)=f(2x)$.

*Solution by C. W. Trigg, Los Angeles City College*

$$(4f(x)+4f(x+1)=f(2x)$$
$$4x(x-1)(x-2)+4(x+1)x(x-1)=2x(2x-1)(2x-2)$$
$$4x(x-1)(2x-1)=4x(2x-1)(x-1).$$

So, since the given equation is an identity, it is satisfied by all values of $x$.

A solution was also offered by A. R. Haynes, Tacoma, Wash.; Leon Bankoff, Los Angeles.

**2318.** *Proposed by Hugo Brandt, Chicago.*

A rectangular piece of paper $ABCD$ with width $AB=w$, length $BC=l$, where $l/2<w<l$ is folded along line $EF$, with $E$ on $AD$ and $F$ on $BC$ in such a way that $C$ falls on $AB$ and angle $BC'F=45°$. Find length of $EF$ without use of trigonometric tables.

*Solution by A. R. Haynes, Tacoma, Wash.*

Let $BC'=a$. Then $C'F=a\sqrt{2}$.
Also $AC'=w-a$ and $C'G=\sqrt{2}(w-a)$.

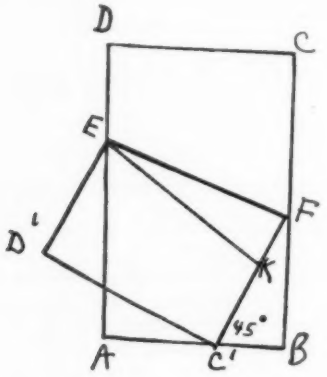
$$D'G=w-\sqrt{2}(w-a)$$
$$D'G=D'E=C'K$$
$$\therefore\quad FK=C'F-C'K$$
$$=w(\sqrt{2}-1)$$

$$EK = w.$$

Hence

$$EF = \sqrt{EK^2 + FK^2}$$
$$= w\sqrt{4 - 2\sqrt{2}}$$
$$= 1.082w.$$

Solutions were also offered by Leon Bankoff, Los Angeles and the proposer.




**2319.** *Proposed by C. W. Trigg, Los Angeles City College.*

Find the unique integer of the form $abbbc$, $b \neq c$, whose square decreased by unity is a permutation of the ten digits.

*Solution by the Proposer*

If the permutation is $P$, then $P = (N+1)(N-1)$. Since the sum of the digits of $P$ is divisible by 9, either $N+1$ or $N-1$ must be divisible by 9. Furthermore $31984 < N < 98427$. There are 131 eligible numbers of the desired pattern within this range. Most of these may be eliminated with the aid of a table of squares of four-digit integers, leaving only 44441, 44443 and 62225 to be multiplied out in any detail. The latter proves to be the unique solution, $62225^2 - 1 = 3871950624$.

Note: If the restriction of a particular form is removed from $N$ there are thirty-four solutions.

A solution was also offered by Leon Bankoff, Los Angeles.

**2320.** *Proposed by Hugo Brandt, Chicago.*

Find an expression for

$$S_n = \sum_{k=a}^{n} \frac{k!}{(k-a)!}$$

with $a$, an integer.

*Solution by the Proposer*

We shall show by "mathematical induction" that

$$S_n = \frac{(n+1)!}{(a+1)(n-a)!} \tag{1}$$

is the desired formula.

First, we want to show that *if* the formula (1) is good for any $k$, it is good for $k+1$, too.

$$S_k=\frac{(k+1)!}{(a+1)(k-a)!};$$

to find $S_{k+1}$ by actual addition of the next member

$$\frac{(k+1)!}{(k+1-a)!} \quad \text{or} \quad \frac{(k+1)!}{(k-a)!(k-a+1)},$$

yields

$$S_{k+1}=\frac{(k+1)!}{(a+1)(k-a)!}+\frac{(k+1)!}{(k-a)!(k-a+1)}=\frac{(k+1)!}{(k-a)!}\left[\frac{1}{a+1}+\frac{1}{k-a+1}\right]$$

$$S_{k+1}=\frac{(k+1)!(k+2)}{(a+1)(k-a)!(k-a+1)}=\frac{(k+2)!}{(a+1)(k+1-a)!}.$$

But this result is exactly what formula (1) would give us for $n=k+1$, hence it is true for $n=k+1$, *if* it is true for $n=k$.

Second, it remains to show that (1) *is* true for some particular $k$, or $n$, say, for $n=a$. In this case, the sum reduces to

$$S_a=\frac{a!}{(a-a)!}=\frac{a!}{0!}=a!,$$

since $0!=1$; formula (1) yields

$$S_a=\frac{(a+1)!}{(a+1)\cdot 0!}=a!.$$

Hence (1) is true for $n=a$, and all values for $n$ greater than $a$, hence it is generally true.

Solutions were also offered by: Leon Bankoff, Los Angeles; Aaron Buchman, Buffalo, N. Y.

**2321.** *Proposed by William W. Johnson, Cleveland.*

Show by trigonometry, and also by geometry, that a triangle is determined when the area, an angle, and the side opposite that angle are given.

*Solution by Leon Bankoff, Los Angeles, Calif.*

1) By trigonometry, we have from the given data,

$$R=\frac{a \csc A}{2}.$$

Since

$$S=\frac{ab \sin c}{2}$$

and $h_a=b \sin C$, we find

$$h_a=\frac{2S}{a}.$$

Knowing $R$ and $h_a$, the triangle is determined.

2) By geometry: If $A$ and $a$ are given, the circumcircle of the required triangle is determined, for chord $a$ subtends an angle of $2A$ at the circumcenter; hence the circumcenter lies on the intersection of two lines making angles of $(90°-A)$ with the extremities of $a$. The altitude on $a$ lies on a line parallel to $a$ and at a distance $h$ from it, where

$$h=\frac{2\times\text{Area}}{a}.$$

the intersections of these two loci determine the vertices of two inversely similar and congruent triangles.

Solutions were also offered by: Margaret Joseph, Milwaukee, Wis.; and A. R. Haynes, Tacoma, Wash.

**2322.** *Proposed by Richard H. Bates, Milford, N. Y.*

Resolve into prime factors:

$$a^4+b^4+c^4-2(a^2b^2+a^2c^2+bc^2).$$

*Solution by David Netboy, San Anselmo, Calif.*

$$\begin{aligned} a^4+b^4+c^4-2(a^2b^2+a^2c^2+b^2c^2) &= [a^4+b^4+c^4+(2a^2b^2-2a^2c^2-2b^2c^2)]-4a^2b^2 \\ &= (a^2+b^2-c^2)^2-4a^2b^2 \\ &= (a^2+b^2-c^2-2ab)(a^2+b^2-c^2+2ab) \\ &= [(a-b)^2-c^2][(a+b)^2-c^2] \\ &= (a-b-c)(a-b+c)(a+b-c)(a+b+c). \end{aligned}$$

Solutions were also offered by: C. W. Trigg, Los Angeles City College; D. McLevd, Winnipeg, Canada; Leon Bankoff, Los Angeles and A. R. Haynes, Tacoma, Wash.

## PROBLEMS FOR SOLUTION

**2335.** *Proposed by Clara Bonard.*

Construct the right triangle, given any median and any two ex-circle radii.

**2336.** *Proposed by C. W. Trigg, Los Angeles City College.*

If $N=M^KP$, then $N$ has a factor $\leqq N^{1/(K+1)}$.

**2337.** *Proposed by Roy Wild, Moscow, Idaho.*

Solve the differential equation:

$$\frac{dy}{dx}=\frac{xy}{\sqrt{k^2-x^2y^2}}.$$

**2338.** *Proposed by Richard H. Bates, Milford, N. Y.*

Show that the difference between the squares of any two odd primes is divisible by 8.

**2339.** *Proposed by Leon Bankoff, Los Angeles.*

Show that

$$\theta=\sin 2\theta-\frac{\sin 4\theta}{2}+\frac{\sin 6\theta}{3}-\frac{\sin 8\theta}{4}+\cdots$$

for

$$\frac{-\pi}{2}<\theta<\frac{\pi}{2}.$$

**2340.** *Proposed by Hugo Brandt, Chicago.*

Show that the summation,

$$\sum_{n=a}^{\infty}\frac{1}{n^2}$$

is approximately

$$\frac{1}{a}+\frac{1}{2a^2}$$

for $a$, sufficiently large.

## HIGH SCHOOL HONOR ROLL

**The Editor will be very happy to make special mention of high school classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.**

**Editor's Note: For a time each high school contributor will receive a copy of the magazine in which the student's name appears.**

**For this issue the Honor Roll appears below.**

**2317.** *Richard Weinberg, Chicago.*

**2319.** *Mary A. Meier, Sheboygan, Wis.*

**2321.** *Miller Peck, Pittsburgh, Pa.*

**2322.** *Bob Strahan, Short Hills, N. J.; John A. Long, Millburn, N. J.; William Ryan, Milwaukee, Wis.; Grace Hicks, Austin, Pa.; Donald Partridge, San Anselmo, Calif.; Michael Moffet, San Anselmo, Calif.; Hazel Holt, Ovid, N. Y.; Aden Clawson, Lakemont, N. Y.; Matis Smith, Romulus, N. Y.; Neal Williams, Gladewater, Tex.*

EDITOR'S NOTE: In the June 1952 issue Mr. Trigg offered a solution to **2293.** He discovered an error in his solution. Below is given his correct solution.

**2293.** *Proposed by V. C. Bailey, Evansville, Indiana.*

Three circles whose radii are $a$, $b$, $c$ touch each other externally. Prove that the lengths of the radii of the two circles which touch the three circles are

$$abc/[(ab+bc+ca)\pm 2\sqrt{abc(a+b+c)}\,].$$

*Corrected Solution by C. W. Trigg, Los Angeles City College*

This is problem 29, page 216 of the 4th edition (1918) of E. W. Hobson, *A Treatise on Plane Trigonometry*. That the formula is incorrect is evident upon putting $a=b=c$, whereupon the radii become $a/(3\pm 2\sqrt{3})$, so that one of them is negative.

In the solution published in SCHOOL SCIENCE AND MATHEMATICS, 52, 490 (June 1952), equation (2) applies only to the radius of the smaller circle and in the final result only the positive sign applies, so that

$$r=abc/[(ab+bc+ca)+2\sqrt{abc(a+b+c)}\,].$$

The corresponding equation involving the radius of the larger circle is

$$[(ab+bc+ca)^2-4abc(a+b+c)\,]r^2+2abc(ab+bc+ca)r+a^2b^2c^2=0.$$

This has the solutions

$$r=abc/[-(ab+bc+ca)\pm 2\sqrt{abc(a+b+c)}\,].$$

Obviously, again only the positive sign applies, so that the radii of the two circles which touch the three circles are

$$abc/[2\sqrt{abc(a+b+c)}\pm(ab+bc+ca)\,].$$

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"Milk box" placed outside the house gives the milkman a place to leave milk when the housewife is not at home to bring it inside. The metal box, well insulated with vermiculite, protects the milk for several hours from biting cold or tepid heat, and is available in four-, six- and eight-bottle sizes.

## BOOKS AND PAMPHLETS RECEIVED

GENERAL TRADE MATHEMATICS, Second Edition, by Edwin P. Leuven, B.S., *Formerly of the Department of Mechanical Arts, Bakersfield High School and Bakersfield College, Bakersfield, California.* Cloth. Pages viii+553. 14.5×23 cm. 1952. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York 36, N. Y. Price $3.80.

MORE MODERN WONDERS AND HOW THEY WORK, by Captain Burr W. Leyson, *Author of "Atomic Energy in War and Peace,"* etc. Cloth. 192 pages. 13×20.5 cm. 1952. E. P. Dutton and Company, Inc., 300 Fourth Avenue, New York 10, N. Y. Price $3.50.

SOIL MICROBIOLOGY, by Selman A. Waksman, *Professor of Microbiology, Rutgers University.* Cloth. Pages vii+356. 14×23 cm. 1952. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. Price $6.00.

BETWEEN PACIFIC TIDES, by Edward F. Ricketts and Jack Calvin, Third Edition. Revised by Joel W. Hedgpeth of the Scripps Institution of Oceanography. Cloth. Pages xiii+502. 15×23 cm. 1952. Stanford University Press, Stanford, Calif. Price $6.00.

METHODS OF STATISTICAL ANALYSIS, Second Edition, by Cyril H. Goulden, *Chief of the Cereal Division, Central Experimental Farm, Ottawa, Canada.* Cloth. Pages vi+467. 14.5×23 cm. 1952. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. Price $7.50.

PLANTS OF THE BIBLE, by Harold N. Moldenke, Ph.D., *Curator and Administrator of The Herbarium, New York Botanical Gardens,* and Alma L. Moldenke, B.A., *Biology Department, Evander Childs High School.* Cloth. Pages xix+328+35. 16.5×26 cm. 1952. The Chronica Botanica Company, Waltham 54, Mass. Price $7.50.

EVOLUTION AND HUMAN DESTINY, by Fred Kohler. Cloth. 120 pages. 13×19 cm. 1952. Philosophical Library, 15 E. 40th Street, New York, N. Y. Price $2.75.

WELLSPRING OF DEMOCRACY, by John M. Brewer, *Associate Professor of Education, Emeritus, Harvard University.* Cloth. Pages xii+232. 13.5×20 cm. 1952. Philosophical Library, 15 E. 40th Street, New York, N. Y. Price $4.50.

DEVELOPMENT OF THE GUIDED MISSILE, by Kenneth W. Gatland. Cloth. Pages x+133. 14×21.5 cm. 1952. Philosophical Library, 15 E. 40th Street, New York, N. Y. Price $3.75.

THE BRITISH ATOMIC ENERGY RESEARCH ESTABLISHMENT. Cloth. 128 pages. 14.5×24 cm. 1952. Philosophical Library, 15 E. 40th Street, New York 16, N. Y. Price $3.75.

SCIENCE AND HYPOTHESIS, by H. Poincaré, *Member of the Institute of France.* Paper. Pages xxvii+244. 13×20 cm. 1952. Dover Publications, Inc., 1780 Broadway, New York 19, N. Y. Price $1.25 Paperbound, $2.50 Clothbound.

SCIENCE AND METHOD, by Henri Poincaré. Translated by Francis Maitland. Paper. 288 pages. 13×20 cm. 1952. Dover Publications, Inc., 1780 Broadway, New York 19, N. Y. Price $1.25 Paperbound, $2.50 Clothbound.

TEACHERS MANUAL WITH ANSWERS FOR MATHEMATICS, A Second Course, by Myron F. Rosskopf, Harold D. Aten, and William D. Reeve. Paper. 64 pages. 15×22.5 cm. 1952. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York 36, N. Y.

EDUCATION FOR ALL AMERICAN YOUTH, by the Educational Policies Commis-

sion. Paper. Pages xi+402. 15×23 cm. 1952. National Educational Association, 1201 Sixteenth Street, Northwest, Washington 6, D. C. Price $2.00.

FINANCING ADULT EDUCATION IN SELECTED SCHOOLS AND COMMUNITY COLLEGES, by Homer Kempfer, *Specialist for General Adult and Post-High-School Education*, and William R. Wood, *Specialist for Junior Colleges and Lower Divisions*. Paper. Pages iv+27. 15×23 cm. Bulletin 1952, No. 8. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price 15 cents.

TEACHING MATERIALS AVAILABLE FOR MATHEMATICS CLASSES, by Kenneth P. Kidd, Ph.D., *Associate Professor of Education, University of Florida, Gainesville, Fla.* Pamphlet. 26 pages. 215×28 cm. 1952. Price 25 cents.

THE LITTLE TREES THAT WENT TO SCHOOL. Pamphlet. 15 pages. 18×25.5 cm. 1952. International Paper Company, Southern Kraft Division, Mobile 9, Ala.

THE TEACHING OF GENERAL BIOLOGY IN THE PUBLIC HIGH SCHOOLS OF THE UNITED STATES, by W. Edgar Martin, *Specialist for Biological Science, Division of State and Local School Systems*. Paper. Pages x+46. 14.5×23.5 cm. Bulletin 1952, No. 9. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price 20 cents.

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## BOOK REVIEWS

BERTRAND RUSSELL'S DICTIONARY OF MIND, MATTER AND MORALS. Edited by Lester E. Denton. Cloth. xiv+290 pages. 15.2×23.0 cm. Philosophical Library, 15 E. 40th St., New York 16, N. Y. Price $5.00.

The Preface is from the hand of Russell himself. The Introduction, by the editor, is largely given to a brief biography of Bertrand Russell.

The arrangement of these brief statements, selected from the writings of Russell, is alphabetical and is said, by the editor, to consist of "more than 1,000 selections from over 100 of (his) books and articles." These and "the cross references enable the reader to follow Lord Russell into many facets of contemporary thought in a wide and astonishing variety of fields." Each item listed is keyed by symbols so that it can be located in the particular article or treatise from which it was lifted. Thus this book becomes a sort of index to the 100 or more writings of Lord Russell.

In addition to the "Key to the Symbols" mentioned above, there are two appendix-like back-page listings: one a bibliography of the works from which the statements were taken and the other "acknowledgements" mostly to the publishers of the works that have been scanned for the statements.

An experienced reviewer, W. E. Garrison, says of this volume, "It makes lively reading, prods the reader's mind with many stimulating and provocative utterances and exhibits the quality and character of the author's thinking. . . . Russell's writings . . . (are products of) a master of sententious statement." This reviewer could not put it more aptly.

Young scientists and mathematicians often become so engrossed in the minutiae of their fields as to entirely neglect the larger philosophical aspects of them. Conceivably this volume might help to correct that mis-emphasis. However, its use for that purpose has a hazard: getting an integrated philosophy from this dictionary would be as laborious as getting a religious philosophy from a book listing only sermon texts.

B. CLIFFORD HENDRICKS
*457 24th Ave., Longview, Wash.*

TODAY'S SCIENCE AND YOU, by Lynn Poole, *Producer of Johns Hopkins T V*

*Science Review*. Cloth. Pages 208. 14.6×21.0 cm. 1952. McGraw-Hill Book Co. Inc. 330 West 42d St., New York 36, N. Y. Price $2.75.

Much of the matter in this book was drawn from the television program known as The Johns Hopkins Science in Review. By the help of pen and ink drawings, many of cartoon-like quality, by Jeanne Bendick, the author does a very effective job of re-relating that which previously went "over the air" as visual demonstration and oral exposition.

In sixteen chapters and 100 drawings and diagrams appear: X-ray the Sleuth; The Magnificent Microscope; Rockets, Seventy-Eight Miles Up; Colors to See With; Industrial Water Pollution; Schistosomiasis and others equally intriguing. "With fresh dramatic . . . (narrative) . . . (it) takes up live, exciting material from the point at which more formal studies of science stop. It brings the reader into close contact with living scientists and relates the progress of science to human welfare."

Its vocabulary is nontechnical and both Illustrations and narrative are interest-holding. A ten page index opens its pages for reference use. Every teacher of science should read it; every reader who opens it to brouse will probably stay with it to page 197's closing paragraph.

B. CLIFFORD HENDRICKS

KING SOLOMON'S RING, by Konrad Z. Lorenz. Cloth. Pages xix+202. 13.5×20.5 cm. 1952. Thomas Crowell Company, 432 Fourth Avenue, New York 16, N. Y. Price $4.00.

Dr. Lorenz remarks, "I hope to convey to my kindly reader at least a slight inkling of the infinite beauty of our fellow creatures and their life." He does so by telling how his household has always been a place where the higher animals can live in unrestricted freedom; that has been his specialty, and he has indulged in it with nearly every imaginable bird, mammal, reptile, fish, and insect. As a result, he passes along a great amount of new information on the understanding of animals. One of these revelations is the phenomenon of "imprinting"—whereby, for example, Dr. Lorenz becomes foster parent of baby goslings and the leader of a group of jackdaws. This is, in short, an unusual Nature book, for its entertaining and humorous anecdotes contain much new information about the animal kingdom.

GEORGE S. FICHTER
*Oxford, Ohio*

PROBLEMS OF LIFE: AN EVALUATION OF MODERN BIOLOGICAL THOUGHT, by Ludwig von Bertalanffy, *University of Ottawa, Canada, Late Professor of the University of Vienna*. Cloth. Pages xi+216. 13.5×21.5 cm. 1952. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. Price $4.00.

*Problems of Life* is a survey of the whole field of biology interpreted as the author's years of experience and study direct him. He calls his new approach the *organismic conception*, and he points out through his text the parallelisms and integrations of biological knowledge and ideas in the various allied sciences. All of this leads up to and is concluded in his final chapter called "The Unity of Science." This book, translated from the German original *Das Biologische Weltbild*, is obviously no general text reference but rather is of worth only to those students and teachers who want to delve deeply into the theoretical as well as the practical phase of science. It is not a book which answers many questions. Instead, it serves as a stimulant; it evokes questions; it starts new thought channels; and thus it is a reminder that science is a fathoming process and that there is no stopping point.

GEORGE S. FICHTER

READ UP ON LIFE, Volume One, by Harold H. Wagenheim, *Chairman of Department, Academic Subjects, Bronx Vocational High School, New York City;* Elizabeth Voris Brattig, *Teacher of English, Erasmus Hall High School, New York*

*City;* Rudolph Flesch, *Instructor in Practical Writing, New York University;* and Dorothy Canfield Fisher, *Lecturer at the Bread Loaf School of English, Middlebury College.* Cloth. Pages xi+507. 18×25 cm. 1952. Henry Holt and Company, 383 Madison Avenue, New York 17, New York. Price $3.40.

*Read Up On Life* contains a carefully gone-over selection of stories which are highly entertaining as well as instructive and which emphasize the contemporary viewpoint. The stories are grouped according to what they are about rather than by "literary eras." Thus, the first group, called "The Younger Set," consists of stories about the problems which teen-agers encounter in growing up. Other sections of the book are: "Bag of Surprises," "Fair Play—and Foul," "Sidelights on America," "Life With Parents," "Facing Life," "This Wide World," and "The Things That Count." While quality of workmanship is not the sole factor in selection of a story, essay, or poem for inclusion in the book, quality is not by any means overlooked. Dorothy Canfield Fisher lent her distinguished counsel for each of the pieces chosen. And Dr. Rudolf Flesch, famous for his *Marks of a Readable Style,* employed his readability yardstick to make certain each selection would reach its mark unerringly. All in all, this literature book is indeed unusual in its stress on human life and its real motives, and science teachers would do well to call it to attention for curriculum consideration.

GEORGE S. FICHTER

HOW TO PASS RADIO LICENSE EXAMINATIONS, Third Edition, by Charles E. Drew. Paper, 376 pages. 15.5 cm.×23.5 cm., John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. Price $4.50.

The Federal Communications Commission examinations for commercial radio and radiotelegraph operator licenses consist of eight parts or Elements. This book treats serially the questions included in the first six of these Elements. Element 7 pertaining to aircraft radiotelegraphy and Element 8 dealing with repair and maintenance of radar equipment are considered of less general interest and hence are omitted.

Each examination question is stated and its answer given. In most cases adequate discussion is given with the answer, although in some cases more clarification might be desired. Numerical problems are generally worked out in full detail. Excellent circuit diagrams are given in the answers to questions requiring diagrams. Block diagrams are often used to indicate the relation and functions of parts of a particular radio system.

This question-and-answer manual is not a textbook. The reader must have a good foundation in electronics and radio engineering to comprehend the answers and explanations. The book deals exclusively with *commercial* radio operators license examinations and refers only incidentally to *amateur* radio operator license examinations. A prospective amateur radio operator might well find this book quite difficult reading.

The text is clearly written. There is considerable repetition but this is probably incidental to treating the actual examination questions serially. The few errors observed by this reviewer appear to be typographical rather than fundamental in nature. Illustrations are found in the definition of a coulomb (in 3.41) as "a unit quantity of electricity equal to one ampere *per* second" and the statement (in 4.12) that the hysteresis loss in a transformer varies as "the 1.6 power of the *frequency.*" However, as a whole, this book is remarkably free from errors and misstatements. These questions and answers would be most helpful to anyone preparing for an FCC commercial operator license examination.

WALTER G. MARBURGER
*Western Michigan College of Education*
*Kalamazoo, Michigan*

BEGINNING ELECTRICITY, by J. R. Eaton, *Professor of Electrical Engineering, Purdue University, Lafayette, Indiana.* Cloth. Pages viii+365. 14.5×23 cm. 1952. The Macmillan Company, 60 Fifth Avenue, New York 11, N. Y. Price $5.50.

As stated by the author in the Introduction, "This book is written for anyone who is not an electrical engineer; the butcher, the baker, the candlestick maker, the homemaker, the electrical service man, the high school student,—anyone with enough curiosity to work a crossword puzzle and enough mathematical knowledge to buy groceries without being shortchanged."

The author presents the fundamental facts and principles of electricity in 32 short chapters. Each chapter is organized around a single basic principle such as Ohm's Law or the Work Law, or around a single type of application, such as the Transformer or Electric Communication Systems. The first 12 chapters deal with the Basic Ideas of electricity. These are followed in turn by groups of chapters on Direct Current Applications, Alternating Current Concepts, Electronics, Electrical Measuring Instruments, and Communication Systems. Each chapter concludes with a summary and a set of questions and exercises for the student reader. These questions and exercises are well chosen to clarify and emphasize the main ideas treated in the chapter.

This book is characterized by the many practical clear illustrations used in developing the different concepts, principles and laws. In those illustrations which are quantitative, the author has been very careful to trace out in detail the steps in the mathematical reasoning involved. Mathematical operations are largely limited to the fundamental processes of arithmetic although in some instances a knowledge of the simple processes of algebra is helpful. Simple graphic methods for adding vectors are developed in the introduction to alternating voltages and currents. The author has achieved notable success in treating sinusoidal functions and AC circuit problems without the use of trigonometry or calculus.

The language of this book is simple and easy to understand. When a technical term is necessary to express an idea or concept, that term is generally defined and explained. The wide experience of the author, both in engineering and in teaching, is reflected in the wealth of illustrative and explanatory material and in the accuracy of the statements and expressions used in this book.

Any beginning student of electricity should find this book interesting and generally easy to understand. Even the more difficult aspects of alternating currents as presented in this text should be within the comprehension of a student who has mastered the fundamental principles treated earlier in the book.

WALTER G. MARBURGER

PRACTICAL MATHEMATICS. PART IV. TRIGONOMETRY AND LOGARITHMS, by Claude Irwin Palmer, *Late Professor of Mathematics and Dean of Students Armour Institute of Technology* and Samuel Fletcher Bibb, *Associate Professor of Mathematics, Illinois Institute of Technology, Armour College of Engineering*, Fifth Edition, Cloth. Pages xii to 193. 14×20 cm. 1951. McGraw-Hill Book Company, Inc. New York.

The first chapter of the book is devoted to logarithms. The authors, in the main, assume a knowledge of exponents and give a good standard presentation of logarithms. It is the last 13 pages of application to practical formulas and problems that makes this chapter unique.

The remaining 131 pages, 8 chapters, are given over to Trigonometry. Chapter 2 develops the concept and meaning of the general angle. The definitions for the six ratios "for any angle" are given at the beginning of chapter 3. This is followed by a discussion of the exact value of the ratios for special angles and the computation of approximate values by measurement of the remaining angles. There is some application to the right triangle here. However, the next chapter teaches the use of the tables before the standard problem of solving the right triangle is presented. This work on the tables involves the evaluations of practical formulas containing the "trig" ratios. Then in chapter 5 we find the problems of the right triangle. The exercises are practical and useful—projection, bearing, vector, belts, area, spiral, index of reflection, etc.

In the topic of "Relations Between Trigonometric Functions" only a very limited number of identities are considered. This is in keeping with a sentence of the preface: "In Trigonometry, those parts are emphasized that may be applied directly to practical problems; while the portions chiefly necessary as an aid in the study of more advanced mathematical subjects are treated less completely." The work in graphical representation is in keeping with the same quotation. The chapter on "Functions involving more than one angle" is brief. The usual formulas are given with little proof or application. It is in the next and last chapter, "Solution of oblique triangles," that we find the theme of the text again. Here are applications to areas, resultants, etc.

The appendix contains: Summary of trigonometric formulas, useful numbers, four place tables of common logarithms, four place tables of trigonometric functions and their logarithms, index, and answers to problems.

FOREST MONTGOMERY
*Lyons Township High School and Junior College*
*La Grange, Illinois*

EVERYDAY PHYSICS, by Ole A. Nelson, *Wilson High School, St. Paul, Minnesota* and John G. Winans, *Associate Professor of Physics, University of Wisconsin.* 586 pages+20 pages appendix and glossary. 18×24 cm. Ginn and Company, 2301 Prairie Ave., Chicago 16, Ill. 1952. Price $4.36.

This physics book is really different. It approaches physics from the standpoint of use in daily living. It contains ten units. The titles give a hint to the nature of the book. I—The Home; II—Heat for Comfort; III—The Age of Electricity; IV—Heat in the Kitchen; V—Light and Vision; VI—Science and Recreation; VII—Communication; VIII—Less Known Scientific Developments; IX—Motor Transportation; X—Air Transportation.

The book is written primarily for the majority of students that will not go on to become scientists. The book emphasizes the usual physics principles by the use of familiar applications as will be noted in the titles.

The book is sufficient in length to allow flexibility to meet the interests and needs of the students as well as those of the teacher.

Each chapter begins with several practical questions concerning the content. The page format is two column. Many diagrams aid the student to understand the mechanics of familiar objects. The chapters end with problems, things to do, and questions. These are well selected and offer opportunity for individualization of the project work.

At first glance the usual mathematics seems to be left out. But on closer examination it is there, but not emphasized as usual. But this is another feature of the book you will want to check for yourself. Some classes will want more math, while in many cases that is one of the students' objections to physics.

E. WAYNE GROSS

INTRODUCTION TO CONCEPTS AND THEORIES IN PHYSICAL SCIENCE, by Gerald Holton, Ph.D., Assistant Professor of Physics and of General Education in the Physical Sciences, Harvard University. Cloth. Pages xviii+650. 14×21.5 cm. 1952. Addison-Wesley Press, Inc., Kendall Square, Cambridge 42, Mass. Price $6.50.

This book seems to have been written to fulfill the place suggested for a physical science course in the Report on "General Education in a Free Society." (The 1945 Harvard Report.) The author is well qualified, having many years of experience teaching such general education science courses.

The style of writing clears away a lot of superfluous material. It is written so as to get a serious student to thinking rather than memorizing. Students can get out of a difficult problem in first courses in physics by either memorizing their way out, or thinking the difficult point through. Naturally only the latter way gives the student complete understanding.

The problems also provide a stimulus for thought. The problems not only

stimulate thinking, but lead to a better understanding and development of initiative on the part of the student.

The author gets to the end result of every aspect discussed. For example, he goes from beginning principles of motion to celestial mechanics; from beginning light to spectral studies. This seems like a good procedure, for often even the physics major doesn't get these applications until later. In many of the general course texts they do not get to these interesting aspects at all, and these help make any such course meaningful and interesting.

The book could be recommended highly for pre-med and better students. But college freshmen that have had only one year of high school mathematics might find the going rough unless they have an excellent instructor. However, all students could understand and benefit from the non-quantitative and thought aspects of this text.

The 25 chapters make up the seven parts of the book. Part A. The Study of Motion; B. The Study of Forces; C. Laws of Planetary Motion; D. Structure and Method in Physical Science; E. The Laws of Conservation; F. Origins of the Atomic Theory; G. Quantum Theory and the Nuclear Atom.

RICHARD W. HUGGETT
*Indiana University*
*Bloomington, Indiana*

OPTICKS—OR A TREATISE OF THE REFLECTIONS, REFRACTIONS, INFLECTIONS AND COLOURS OF LIGHT, by Sir Isaac Newton. Based on the Fourth Edition, London, 1730. With a Foreword by Albert Einstein; an Introduction by Sir Edmund Whittaker; a Preface by I. Bernard Cohen; an Analytical Table of Contents prepared by Duane H. D. Roller. Dover Publications 1952. Clothbound $4.00; Paperbound $1.90.

I have had occasion in these columns to "review" certain classical treatises, and as I have said before, *who is able to "review" them?* In the first place, they need no *re*view, if by this we mean an appraisal afresh. These classical volumes are *always* fresh. All they require is that they be brought again to the attention of interested persons. In the case of the present volume, first published in 1704, the viewpoint is surprisingly contemporary, if one properly regards the corpuscular notions of light phenomena.

The array of introductory remarks by Einstein and Whittaker and Cohen is alone worth the price. And as for what Newton himself says I quote from Albert Einstein: "He who has time and tranquillity can by reading this book live again the wonderful events which the great Newton experienced in his young days."

No serious student of physics can afford to say that he has never read Newton's *Opticks*. Students in other quarters will find the exposition delightful.

JULIUS SUMNER MILLER
*Ford Foundation Fellow*
*University of California*

THE ELECTROMAGNETIC FIELD, by Max Mason and Warren Weaver. About 400 pages. Dover Publications. Cloth $3.95; Paper $1.85.

This treatise appeared more than 20 years ago, and as a classic has never been replaced. It presents in elegant exposition a complete introduction to the mathematical field theory of electrodynamics, keeping clear at all times the relation between the mathematical mechanism and the physical reality.

The arrangement of material proceeds from Coulomb's Law, the Electrostatic Problem for Conductors and Dielectrics, Magnetostatics to the Maxwell Field Equations. Problems are provided, and the Conclusions to the chapters are masterful summaries. The final Conclusion (to Chapter IV) is powerfully written. There is a Mathematical Appendix, a Table for Change of Units, and a Formula Index.

With the present problems in electrodynamics which now face us this treatise constitutes an unexcelled background.

JULIUS SUMNER MILLER

THE SCIENTIFIC PAPERS OF JAMES CLERK MAXWELL. Complete and unabridged; Two volumes bound as One. 1,488 pages. 14 full-page plates; 88 illustrations. Dover Publications. $10.

This edition contains all the published papers, lectures and addresses, essays, and short treatises of the greatest theoretical physicist of the 19th century. As J. J. Thomson said: "His papers were models of clear and brilliant expression." It is a treat of the highest order to read *in the original* the investigations which gave such solid foundation to the fabulous domain of electromagnetic theory and its applications.

These classicists wrote in a style which is forever enviable, and present-day investigators would profit immeasurably from following the exposition. Here we come face to face with the *original* ideas of the greatest of theoreticians and it is a stirring experience to read:

"The theory I propose may therefore be called a theory of the *Electromagnetic Field*, because it has to do with the space in the neighbourhood of the electric or magnetic bodies, and it may be called a *Dynamical* Theory. . . ." Here was history made!

Maxwell's inquiries, as we know, led inescapably to a consideration of gravitational forces, and he finally writes: "As I am unable to understand in what way a medium can possess such properties, I cannot go any further in this direction in searching for the cause of gravitation." It is well to point out that nothing further or more definitive has even yet been stated.

Nowhere can ten dollars provide such abundant pleasure.

JULIUS SUMNER MILLER

THE NATURE OF SOME OF OUR PHYSICAL CONCEPTS, by P. W. Bridgman. 64 pages. Philosophical Library 1952. $2.75.

This little volume contains three lectures given at the University of London in the Spring of 1950. The particular object was to distinguish between the "instrumental" and the "paper and pen" component of the operations of the physicist. In the first lecture, among others, the concepts of field and empty space are examined, and it is shown that there is no instrumental operation by which action at a distance can be distinguished from action through a field. In the second lecture the fundamental concepts of thermodynamics are examined, and in the third the phenomena of conduction of electricity in massive conductors.

Professor Bridgman is professor of physics at Harvard and a Nobel Laureate. His operational point of view is classical. These pages can be read in a sitting and provide a goodly measure of intellectual stimulation.

JULIUS SUMNER MILLER

MECHANICS AND PROPERTIES OF MATTER, by Reginald J. Stephenson, Professor of Physics, The College of Wooster. 371 pages. Wiley 1952. $6.00.

This is a textbook for a semester course presuming a year of physics and a year of calculus. The emphasis is on the physical aspects with a very admirable mathematical treatment. The problems are abundant and good; the exposition literary and smooth. The book possesses a classic temper. Dimensional analysis is introduced, and there are some very excellent historical references.

The book has a sort of European complexion—commendable indeed—and demonstrates a substantial academic experience on the part of the author.

This would serve as an excellent text in Analytical Mechanics, say, a quarter which has been wanting a book *of this sort* for some time.

JULIUS SUMNER MILLER

EVERYDAY GENERAL MATHEMATICS BOOK TWO, by William Betz, *Specialist in Mathematics, Rochester, New York*, A. Brown Miller, *West Technical High School, Cleveland, Ohio*, F. Brooks Miller, *formerly Shaker Jr. High School, Shaker Heights, Ohio*, Elizabeth B. Mitchell, *Charlotte High School, Rochester*,

*New York*, H. Carlisle Taylor, *Head of the Department of Mathematics, Benjamin Franklin High School, Rochester, New York.* Pages ix+440. 1951. Ginn and Company, New York. Price $2.60.

The authors of *Everyday General Mathematics Book Two* are offering a second years work in general mathematics for secondary schools. It has been the intention of the authors to offer material in this text that would prepare a student for many situations of daily living, and at the same time provide a general orientation and a sound foundation for the study of higher mathematics.

In order to fulfill these objectives the text includes units covering such algebraic concepts as formula, equations and problems, signed numbers, fundamental operations, first degree equations in one and two unknowns, special products and factoring, fractions and fractional equations, radicals and quadratic equations. Important social and technical applications of mathematics are considered. Certain geometric ideas and relations including a glimpse of demonstrative geometry are included. Units covering statistics and information about aviation make up a part of the text.

The book contains several commendable features. For example each concept is introduced by a comprehensive discussion and definition of new terms. Important rules are offset by dark print and enclosed in extra heavy rectangular figures. Exercises are graded in difficulty. Basic concepts are reviewed at regular intervals and each chapter contains a summary of the main features of the chapter. The book contains many diagrams, much illustrative material, and has excellent up-to date photographs concerning applications of mathematics.

It is very likely that many schools have been faced with the problem of deciding what material to include in a second year of general mathematics. The selection of such material would naturally depend upon the individual school and the objectives of the mathematics department of that school. *Everyday General Mathematics Book Two* contains an enormous amount of varied material that would be difficult to cover in a two semester course. Because of that fact this book could be adapted easily to the needs of individual classes or schools by careful selection of material.

The authors and publishers have offered their solution to this very difficult problem of content selection for a second year of general mathematics. I am certain the mathematics departments of many schools will find this content adequate and useful.

RICHARD ELLIS
*Lyons Twp. High School*
*La Grange, Illinois*

DANA'S MANUAL OF MINERALOGY, Sixteenth Edition, Revised by Cornelius S. Hurlbut, Jr., *Associate Professor of Mineralogy, Harvard University.* Cloth. Pages viii+530. 14×22 cm. 1952. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. Price $6.00.

Here is a new edition of a book that has been *the* authority in the field of mineralogy since 1848. The 15th edition, which came out in 1941, showed the close relation of mineralogy to physics and chemistry, but many things have been discovered in the past twelve years that have been applied in the study of this science. Physicists have been working on the nature of the solid state, improving the X-ray as an instrument of research, and building the many great machines used in the studies of the structure of matter. Chemistry has contributed much which is put to use in this revision. The author starts by giving the elementary student an introduction to the study, a little of the history of development, and a brief discussion of the nature of minerals. In many places throughout, the text has been improved by the addition of new material, lucid descriptions, more modern explanations, and simpler nomenclature. An old text has been brought up to date and will continue to be the best for use of amateurs, students, collectors, and geologists as well as for the specialists in mineralogy.

G. W. W.

MATHEMATICS: ITS MAGIC AND MASTERY, Second Edition, by Aaron Bakst, *Author of Space and Geometry, The Sextant and How to Use It*, etc. Cloth. Pages xiv+790. 15×23.5 cm. 1952. D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York 3, N. Y. Price $6.00.

This is the second edition of a book published some ten years ago, which has not been available recently. It does not pretend to be a text book, yet it does present a rather broad picture of the scope of mathematics through some aspects of the calculus. It makes no pretense of being "popular" in the sense that it is mathematics without formulas, symbols, or equations, yet the first edition has been in great demand in public libraries. The author's purpose, as stated in the first edition, has been to make mathematics interesting and to develop an appreciation of mathematics as it permeates various fields of human endeavor. He has been eminently successful in attaining his stated objective.

In this edition some misprints and errors have been corrected, and numerical data are brought up to date. It is indeed fine to have this book again available. The development proceeds from the primitive ideas of counting through systems of numeration into unusual properties of numbers. There is a very large number of number tricks and puzzles (with answers)—in fact mathematical recreations form a large part of the book. Algebra, trigonometry, geometry, including discussion of the fourth and higher dimensions, and calculus are all considered informally. Applications to such fields as business, cryptography, probability, astronomy, physics, are found throughout the book.

The book is valuable for high school or college library as well as for the individual teacher. It would be hard to find a more fertile source of material for individual reports, mathematics club programs, of supplementary classroom material. In the entire book, the reviewer objected to only one item—in the appendix, explaining the symbol for infinity, one finds the statement "For example, $5/0=\infty$."

CECIL B. READ
*University of Wichita*

DIFFERENTIAL EQUATIONS, by Robert C. Yates, *United States Military Academy*. Cloth vii+215. 14.5×23 cm. 1952. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, N. Y. Price $3.75.

This text is designed for a first course in which primary emphasis is upon applications rather than theory, in particular, applications to engineering and physical problems. Geometrical problems are decidedly in the minority; the topic of singular solutions which often occupies a chapter or two in a text is omitted except for a short definition of the term.

Certain features are somewhat unique, and seem commendable. The methods of undetermined coefficients and variation of parameters are introduced in connection with first-order equations, allowing a feeling of familiarity with the method when equations of higher order are discussed. Review chapters are inserted at rather frequent intervals; there seems to be an ample supply of problems, in which the author has attempted to present problems in pairs, each pair involving similar processes (this should be helpful in providing alternate assignments). The author presents throughout the book a systematic method for displaying a method used in solving a problem, which has the double advantage of conciseness and being a valuable help in teaching the student orderly arrangement.

The explanations of illustrative applied problems are exceptionally clear, with reasons for the solution often clearly stated (example, the reason for using a transition curve in railway construction). It seemed to the reviewer, however, that as more complex topics were introduced, the discussion became much briefer. Perhaps the student by this time has more maturity.

There is a good introductory discussion of methods using the derivative operator, Legendre and Bessel equations, orthogonal functions, approximate solu-

tions by numerical methods, partial differential equations, and Fourier analysis. With a book of this length, obviously some of the treatment is brief.

This text would seem one of the better books available for a course of this type. Answers are provided for most of the problems.

CECIL B. READ

ECONOMETRICS by Gerhard Tintner, *Professor of Economics, Mathematics and Statistics, Iowa State College of Agriculture and Mechanic Arts, Ames, Iowa.* Cloth. Pages xiii+370. 14.5×23 cm. 1952. John Wiley and Sons, Inc. 440 Fourth Avenue, New York 16, N. Y. Price $5.75.

To read this book intelligently, one must have a background in modern economics, a good knowledge of mathematics at least through the calculus, and familiarity with mathematical statistics. At the very first the author attempts to define his field by distinguishing between econometrics, mathematical economics, and statistical economics. In spite of the fact that in the preface it is stated that the first portion of the book can be followed with little mathematical background, the reader will encounter such concepts as logarithms, methods of least squares, determinants, the use of a derivative, sinusoidal fluctuations, and systems of linear differential equations. From this one may perhaps see something of the mathematical maturity needed to follow the remainder of the text. Some of the material needed in matrix calculus and numerical methods is presented in the Appendix.

The author points out the fact that economic data often come in the form of time series, hence are not independent, and traditional statistical methods, based on random samples, cannot be applied. Methods which are given offer possibilities, but the author points out that they are unsatisfactory in several ways. Some of the examples are shown in considerable detail, others are set forth rather briefly.

This is obviously not an elementary text—it does not, for example, have lists of problems. In many of the illustrations, although the explanation is fairly complete, details of the computation are not furnished—in fact in some examples insufficient data are given for the reader to verify the results if he so desires. The book contains a large number of footnotes giving references to material on the topic in question. Since there is relatively little material available on the relatively new field, this book will be welcomed by those interested in extending their knowledge along this line.

CECIL B. READ

MATHEMATICS IN THE PLANNING OF A MODERN WATCH, by George W. Sauerwald, *Hamilton Watch Company, Lancaster, Pennsylvania.* Paper. 8 pages. 21×28 cm. INSTALLMENT BUYING INTEREST FORMULA, by Lee E. Boyer, *State Teachers College, Millersville, Pennsylvania.* Paper. 5 pages. 21×28 cm. Prepared and Distributed by the Research Committee of Pennsylvania Council of Teachers of Mathematics, Millersville State Teachers College, Millersville, Pa. Price 25 cents each.

These two pamphlets provide interesting supplementary material for classroom work. For example, one finds an interesting application of rectangular coordinates, as well as a moderately complex formula, in the article on the design of a watch. The article on the installment buying rate of interest is very easy to follow. It might have been advisable to point out that if other assumptions are made—for example, the assumption that each payment is in part interest and in part principal—a different rate of interest will be obtained.

CECIL B. READ

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Moreover distrust of speculation often serves as a cover for loose thinking.
A. S. EDDINGTON.